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Nuts & Volts

The Preferred Magazine Of The Electronics Hobbyist/Industry

www.nutsvolts.com

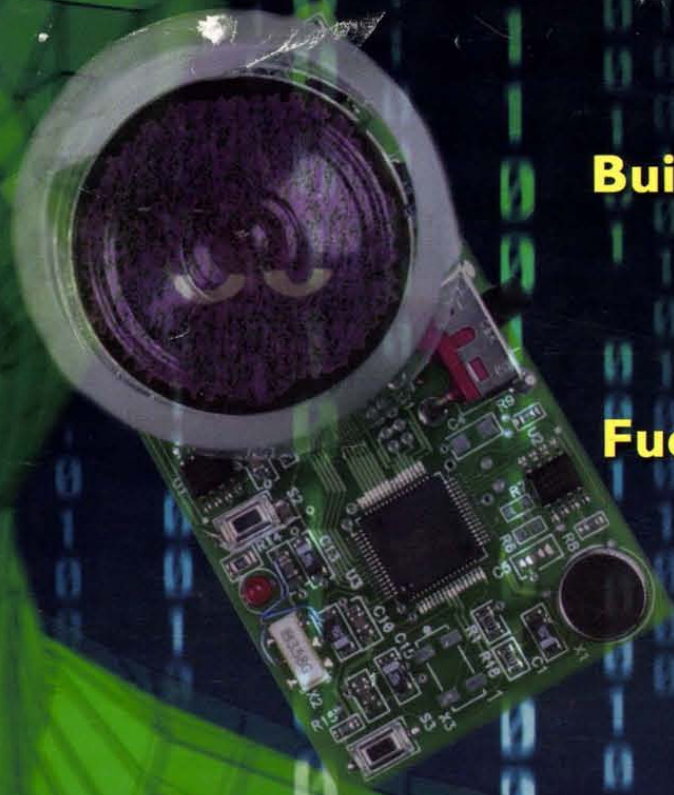
June 2002
Vol. 23 No.6

Enter The MSP430 Gadget-O-Rama 2002 Design Contest! Cash Prizes Totaling $10,000!

Digital Voice Recording With The Texas Instruments MSP430

Build The GlobeSpan World Band Receiver

Fuel Cell Technology Takes Another Step



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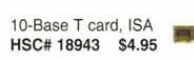

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BASIC ATOM
Whether you are a beginner or a professional programming, microcontrollers has never been easier ! Experiment and test code changes on-the-fly! Bring your projects to life quicker and easier with the Basic Atom !

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Stop wasting time strategically planting debug statements throughout your entire program. The Basic Atom software includes a built-in ICD (In Circuit Debugger). Watch variables, SFRs and RAM values as each line executes. The Basic Atom's ICD is so easy to use, even a first time user can have it up and running in minutes !

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WHAT DOES IT ALL MEAN ?

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TempVar = 200,000

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New commands, more features with each new software release !

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Built in hardware runs independently of the main process. This allows you to generate a pulse or receive serial data while your program is doing something else.

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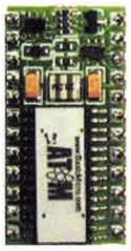

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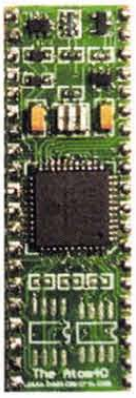

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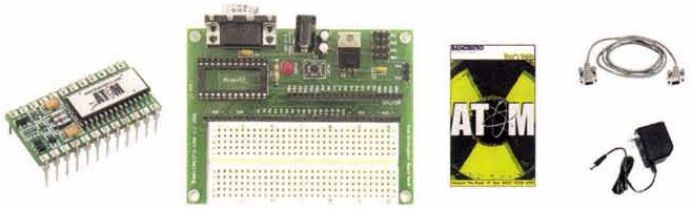
ATOM DEVELOPMENT KITS



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The Super Development Board supports all DIP versions of the Atom including the Atom 40 Pin. The Super Development also includes a high power 1 amp regulator (LM2940), Heat Sink, external battery connector and more !

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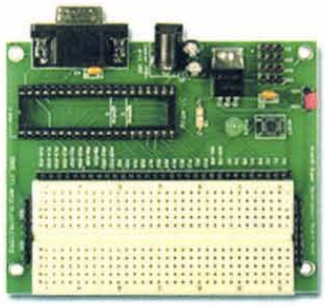

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Nuts & Volts
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JUNE 2002

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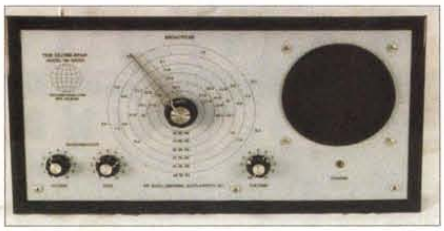

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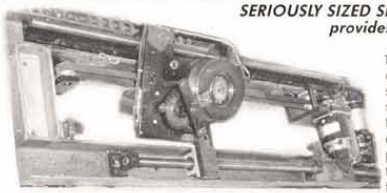

These heavy duty, motorized linear slides, do their sliding on 3/4" diam. Thompson steel rail. The X axis is motivated by a substantial 3.4" diam. EG&G servomotor type: ME3515-191B with an EG&G 1000 count encoder driving a flex coupled 1/2" pulley which belt drives 2.2" diam. transfer pulley which direct drives the 1.5" final drive pulley which moves the 0.6" wide toothed belt which moves the carriage. The X axis carriage contains a motorized rotary unit with the same type EG&G servomotor driving a 5.5" diam. 1/4" thick aluminum platter mounted at about a 20 degrees angle to the base. Rotation is via an anti backlash gearing system directly driven by the motor. Supporting all these goodies is a welded, 3" wide steel channel frame. The system overall size is: 45"L x 14.25"W x 8.75"H. These units must ship via truck. Very limited quantity. These are used in good condition.

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New precision ruled glass. 1.8" diam. x .125" thick. Give your projects a professional touch. Usually quite pricey.

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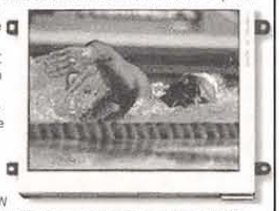

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Regulated 12 VDC/110VAC power supply.....$8.95ea.

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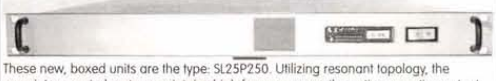

These new, boxed units are the type: SL25P250. Utilizing resonant topology, the proprietary control system maintains high frequency over the entire operation output range. High Frequency operation allows dynamic response time of less than 5 milliseconds and one of the lowest ripple specifications available. Providing +25000VDC @ 10ma with low ripple of 0.02% rms, line and load regulation is 0.005%. Current load regulation: 0.05% of full current for voltage changes and Current line regulation ± 0.05% of full current over the specified input voltage range. 115VAC powered. Size: 1/34"H x 19"W X 19"D rack mountable. Weight is: 17 lbs. Stability of 0.01% per hour after 1/2 hour warm up. 0.02% per 8 hours typical. Temperature coefficient: 100ppm per deg C. Ambient operating temperature: -20C to +40C. Front panel on/off circuit breaker. Other features include, Internal fault protection, front panel indicators for Line power, High voltage OFF and ON, Overload, Interlock status and over temp. These supplies have no front panel controls. The I/O interface is via a 24 position terminal strip at the rear. External 20Kohm pot, not supplied can be used to remote control the current. Outputs are provided for external metering of output. Complete with original instruction manual, schematics, HV output cable and AC line cord. These units are factory set for 25KV out instant on as provided. These are hazardous and potentially deadly voltages. Do not purchase if you do not know what you are doing. Must be over 18. All sales final. **SPELLMAN, SL25KV.....$399ea.**

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EXIDE-NP1812.....$24ea.
Case of 4, EXIDE-NP1812-4.....$89
1amp Charger, EX-CHGR....$15ea.

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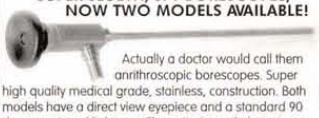
The legendary, close-focusing 105mm f/2.8D AF Micro-Nikkor offers images with stunning detail. Its 105mm focal length adds extra working distance. Now you can accommodate several different lighting techniques with one lens. The exclusive Close-Range Correction System allows focusing as near as 12 inches with a 1:1 reproduction ratio! The super sharp, 105mm focal length is an excellent choice as a portrait lens. SPECS: Construction: 9 elements in 8 groups, Picture Angle: 23° 20', Minimum Focus Distance: 1 foot, Maximum Reproduction Ratio (Macro Setting): 1:1, Filter Size: 52mm, Dimensions: 3" diam. x 4.1"L, Weight: 19.6 oz. This product is brand new in std. NIKON box. Original MANUFACTURERS USA warranty IS included. Nikon 105/2.8 Micro AFD #1988N Ltd. Qty. **NIKON-105.....$429ea.**

SUPERB SLIDE, TRAVERSES 2" with STEPPER DRIVE

The motorized, linear ball slides from NEAT are extremely rigid. No slop with these hefty units. Top and bottom machined from a 1" thick and 1.25" thick solid alum. plate. Flex coupled, 12VDC @ 0.44A Rapidsyn size 23, 6 wire stepper is included. These slides are in excellent condition and removed from equipment. Overall size of slide is 3" x 4" x 2" add 2.75" to length for the stepper. Excellent for applications which require extreme repeatability. Ltd. Qty. **NEAT-3X4...$129ea. 2 for $229**

SUPER SLUETH, SPY BORESCOPES, NOW TWO MODELS AVAILABLE!



Actually a doctor would call them anrithroscopic borescopes. Super high quality medical grade, stainless, construction. Both models have a direct view eyepiece and a standard 90 degree external light port. The unit pictured above is constructed with a 6.5" long X 7.5mm diameter tube with the objective end optic angled at a 30 degrees for easy viewing of surrounding area. The second style, shown below offers a 9.75" long tube with an amazingly small, 2.2mm in diameter with a flat objective end. That could really get you into some tight spots. Reg price: $800ea.

BORESCOPE-6.5".....$229ea.
BORESCOPE-9.75".....$249ea.
BORE-PAIR-6.5"+ 9.75".....$450 per set.

THOMPSON PRECISION STEEL BALL BUSHING, type A162536

These are new, boxed, general purpose closed LINEAR BEARINGS. Size: 2.25"L x 1.56"OD with a 1" diam. bore. Rated for dynamic loads of up to 350lbs. Ltd. qty. **THOMP-BB536.....$22ea.**

HEAVY DUTY, INDUSTRIAL FOOT SWITCH, USA MADE!

Manufactured by Linemaster Switch, their model: 635-S. UL approved. Rated for 15A @ 125VAC, 10A @ 250VAC or 1/2HP. Made for rugged use with all cast metal construction. The foot pedal is surrounded by a steel guard on four sides to prevent accidental activation. Guard can be removed with two screws. Ten foot log, four conductor cable attached. Very nice, superior quality intended for use with medical laser systems. Two independent S.P.S.T. micro switches. One closes at about 50% pedal travel and the other closes at 90%. They are both closed at 90% Overall size including shield: 6"W x 6"D x 4.5"H, Pedal size: 3.5"W x 5"L x 1.75"H Pedal finished in black powder coat. Shield is "putty" color. Weight is 7lbs. No Slip pad on bottom. Limited quantity. **PRICE.....$24ea. or 2 for $45**

NEW, SECURITY MONITOR. NOW YOU HAVE THREE CHOICES!

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BWMONITOR-15HR.....$159ea.
COLORMON-14HR.....$219ea.

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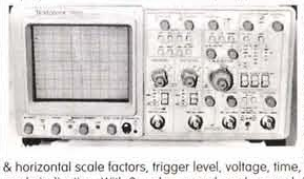
Displays intermittent variations as they happen. Captures the slowest one shot events with 4ns per division a 100 fold increase in the visual writing rate over conventional CRT. Features: 1 ns rise time, 500ps/Div time base, 2mV/Div. vertical sensitivity at 350MHz, 20ps time interval resolution, 1Mohm / 50-ohm input, 500Mhz trigger bandwidth, four channels. On-screen waveform cursors provide vertical & horizontal scale factors, trigger level, voltage, time, freq., phase, ratio values and mode indication. With 2 probes, pouch and manual. EX. cond. 90 day warranty.



New..$12K Now SALE, TEK 2467.....$1995.

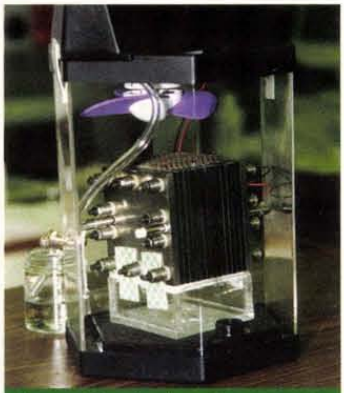
Events, Advances, and News From the Electronics World

by Jeff Eckert

TechKnowledgy 2002

Advanced Technologies

Fuel Cell Technology Takes Another Step



New JPL fuel cell converts methanol into electricity. Courtesy of NASA JPL.

Fuel cell experts at NASA's Jet Propulsion Laboratory, in Pasadena, CA **(www.jpl.nasa.gov)**, have redesigned the traditionally large, bulky stacks of layered fuel cells and transformed them into compact, flat, and relatively lightweight fuel cells. The technology may eventually be used in portable electronic devices such as cell phones, laptops, handheld organizers, and camcorders, providing power for hours or even days at a time.

A major advantage of fuel cells over rechargeable batteries is that they can operate for longer periods of time (for example, 10 hours of continuous power for a laptop computer) without recharging or interruption. Unlike batteries, these fuel cells can be recharged almost instantaneously by refueling them with liquid methanol. And, unlike batteries, the fuel cells do not contain toxic materials and do not present exotic disposal problems.

A fuel cell works on the same principle as a battery, but is continually fed with fuel. In this power source, methanol is put in on one side of the unit while air circulates on the other side. Both are circulated past electrodes and converted to electricity. This process produces no toxic emissions — only carbon dioxide and water as by-products.

Existing fuel cells typically operate at high temperatures, require bulky thermal insulation, and use hydrogen as their energy source. Much of their weight and size is due to the bipolar plates needed to connect several cells to form a stack. JPL researchers have eliminated bipolar plates and created what they call a "monopolar pack," which is flat with the cells linked by electrical interconnects.

To demonstrate the feasibility of the portable fuel cell technology, JPL developed a five-watt portable power unit (see photo). The power source uses the monopolar flat pack technology and is roughly the size of two paperback books. It operates efficiently at ambient temperature.

The next phase underway at JPL is to make it smaller, more robust, and user-friendly. Work on the portable fuel cell technology is sponsored by TechSys, Inc. (Florham Park, NJ).

Microchain Has Potential Microelectro-mechanical Applications

Sandia's microchain can provide space reduction in powering MEMS devices. Courtesy of Sandia National Laboratories.

Displaying yet another way that future microscale and nanoscale electromechanical devices may be powered is a microchain recently fabricated by the US Department of Energy's Sandia National Laboratories **(www.sandia.gov)**. It resembles a bicycle chain, but the distance between the centers of the chain links is only 50 microns (as compared to the diameter of a human hair, 70 microns). Because a single microchain could rotate many drive shafts, the device would make it unnecessary to place multiple tiny microelectromechanical (MEMS) motors in close proximity. Usually, a separate driver powers each MEMS device. The microchain — according to Sandia technician Ed Vernon — could be used to power microcamera shutters, as larger chains currently do in the macroworld. It could also be used in mechanical timing and decoding.

Mr. Vernon noted that the microchain offers advantages over a microbelt because, although silicon belts are tough and flexible, they are spring-like and produce too much torque on gears that are not aligned in a straight line. Each chain link, on the other hand, is capable of plus-or-minus 52 degrees rotation with respect to the preceding link, without creating pressure on the support structure. The wide angle means that MEMS designers can be relatively unconstrained in positioning multiple devices. The longest span unsupported by gears or bracing is 500 microns. A microchain tensioner is needed to accommodate longer spans.

Computers and Networking

This Month's "World's Fastest Supercomputer"

A new Japanese machine is now claiming the title of "world's fastest supercomputer." The NEC Earth Simulator is a high-speed parallel vector computer developed for research on global environmental change. It is a distributed-memory system that consists of 640 processor nodes. Each node is a shared memory system composed of eight arithmetic processors, a shared memory system of 16 GB, a remote control unit, and an I/O processor. The peak performance of each arithmetic processor is 8 GFLOPS. The machine employs 5,120 processors, and the total peak performance and the main memory capacity are 40 TFLOPS and 10 TB, respectively. The system is based on advanced CMOS technology. The machine operates on a UNIX-based OS.

Earth Simulator will be used in an ambitious project to create a "virtual planet Earth," processing data collected from buoys, satellites, and various other global sensory systems. The goal is to analyze and predict environmental trends by simulating such events as seismic activity and wave propagation, land surface temperature distribution, sea surface temperature variations, movement of the Earth's molten core, earthquakes, and so forth. The system was developed by the Earth Simulator Research and Development Center, which is a collaborative organization of the National Space Development Agency of Japan, Japan Atomic Energy Research Institute, and Japan Marine Science and Technology Center. For more information, visit **www.jamstec.go.jp/jamstec-e/earth_simu/index.html**.

Pocket PCs Geared For Commercial Applications

Symbol Technologies' PDT 8100 pocket PC offers WAN and WLAN communications. Courtesy of Symbol Technologies, Inc.

Perhaps you have been curious about the gadgets that are carried around by grocery store clerks, nurses, delivery truck drivers, and others. If so,

you may be interested in **Symbol Technologies' (www.symbol.com)** PDT 8100 series of pocket PC devices. Designed to bridge the gap between pure pen-based and key-based mobile data collection products, the PDT 8100 offers a range of keyboard options to meet mobile data management requirements for various applications and business needs.

For instance, multiple keyboard options are available for data entry efficiency in different environments. Route accounting employees may prefer the 28-key numeric keyboard, whereas retail customers may opt for either a 37- or 47-key alphanumeric keyboard. The appliance may look like a simple data input and storage device, but communication options include Wireless Local Area Network (WLAN) and Wireless Wide Area Network (WWAN) connectivity, which enables the PDT 8100 to deliver data wherever it's needed.

The 8100 uses an Intel® StrongARM processor operating at 206 MHz and runs Microsoft's Pocket PC operating system. It ships with 32 MB or 64 MB of RAM and 32 MB of ROM and also features a VGA display, a backlit keyboard, and a rechargeable, extended-use lithium-ion battery.

With an undiscounted list price of $2,000.00, it's not exactly cheap, but it is sealed to IP54 standards and, according to the company, is extremely rugged. And you can probably get a quantity discount if you are, for example, the Coca-Cola Company, which recently bought 240 of them for its field service technicians, or United Parcel Service, which, according to press reports, will be buying between $50 million and $100 million worth of the company's handhelds.

Coca-Cola will deploy the PDT 8100 to repair and service tens of thousands of vending machines. Using integrated laser bar code scanning, the device will receive work orders, inventory and parts information, and directions to the technician anywhere on the road via satellite communications.

Circuits and Devices

Hot-Swap Controller Enables Live Board Swapping

Analog Devices (www.analog.com) has introduced a family of hot-swap controllers that enable safe board insertion and removal from a live 48V backplane, which allows users to remove and reseat boards without shutting the entire system down. The ADM 1070 is the first in the series, and it is suitable for central office switching applications (such as DSL access multiplexers), power supply controls, high-availability systems, and 48V distributed power systems. It typically operates from a negative voltage of up to 80V, but can tolerate transient voltages of up to 200V.

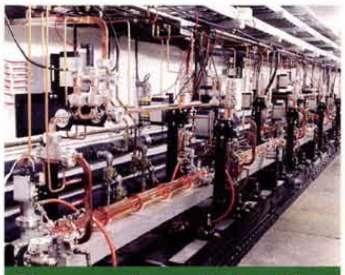
Key features of the ADM1070 are its inrush current control, over-current and short-circuit protection, and limited consecutive retry functions. The load current is monitored to ensure that it remains less than a level programmed by an external sense resistor. If the current exceeds this level, the gate drive to an external FET is modulated to reduce it. Thus, at start-up, the inrush current is kept at a safe level.

After start-up, if the current exceeds the preset level for a programmed time, the current will be limited, and a fault will be registered. An auto-restart is attempted at a programmable time after the over-current event, while pulse-width modulation keeps the FET safe. If the fault persists, the FET drive is latched off after seven consecutive retries, indefinitely disabling the load current.

These features protect against over-current and short-circuit conditions. Programmable time filtering allows transient faults to occur without shutting the system down. The ADM1070 includes single-pin undervoltage/overvoltage detection, and requires only five external components. Fabricated using BiCMOS technology for lower power consumption, the ADM1070 is packaged in a six-lead SOT23 package, which produces a 25 percent reduction in board space over an eight-lead SOIC solution. The price per unit in 1,000 piece quantities is $1.70.

Industry and the Profession

Electron-Positron Linear Collider Proposed



Close-up view of the Next Linear Collider Test Accelerator beamline. Courtesy of Stanford University.

In April, more than 50 physicists from universities and laboratories around the USA met at Cornell University to begin work on a proposal for federal funding for what would be the largest research machine ever built: a multi-billion-dollar, 20-mile-long electron-positron linear collider. Cornell has taken on the task of drafting research and development plans for the accelerator itself and for the detector that would reconstruct the trajectories of the charged particles discovered in the next major step into inner space. The university's Laboratory of Elementary Particle Physics, or LEPP (previously the Newman Laboratory of Nuclear Studies), is organizing a national consortium to submit a proposal to the National Science Foundation (NSF) in September for about $1 million in funding to support the research.

The linear collider would seek to detect the Higgs boson, the holy grail of particle physics, and would also explore supersymmetry and antimatter, providing fun-

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CC-PWC $1.00

6' Printer Cable
IEEE-1284 parallel printer cable. Standard DB25 male to Centronics 36 male.
CC-PR6-1284 $3.50

Circle #51 on the Reader Service Card.

damental details about the origin of the universe, the structure of space, and the nature of matter itself. The machine — actually two high-energy accelerators pointing at each other — would accelerate beams of electrons and positrons at very high energies and hurl them at a microscopic target to see whether newly discovered particles emerge. However, although Department of Energy-funded research on the accelerator has been underway at two US national laboratories for the past decade, there is no agreement on its final design, its funding sources, or even where it will be located. The most likely locations are in the United States, Germany, and Japan. Estimates of the cost range from an estimated $5 billion to $7 billion, depending on which of the four designs is chosen. Information on the Cornell concept can be found at **www.lns.cornell.edu**.

One of the major challenges in constructing the collider is to generate the extremely powerful particle beam that is required to make it operate. Research in this area is being conducted by Stanford University's Next Linear Collider Test Accelerator (NLCTA). This facility is particularly aimed at testing klystrons (microwave generators), accelerator structures, and beam loading compensation. Interesting information is available at Stanford's "Next Linear Collider" web page, **www-project.slac.stanford.edu/nlc/home.html**.

For a simple explanation of how a klystron works, visit **www2.slac.stanford.edu/vvc/accelerators/klystron.html**. And if you are wondering what a Higgs boson is and why you should care, the answer may lie at **www.phy.uct.ac.za/courses/phy400w/particle/higgs.htm**. Then again, it may not.

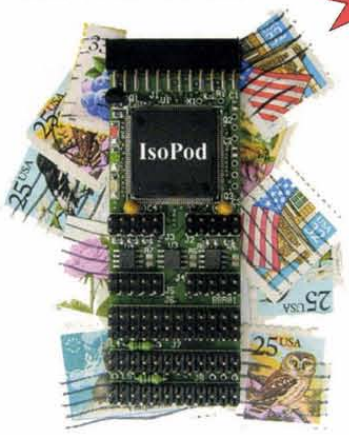
Gates Threatens to Kill Windows

In the continuing legal drama involving Microsoft's alleged anti-competitive practices, nine states that refused to sign the settlement agreement proposed by the federal government are continuing with their own lawsuit. One of their proposed remedies is that Microsoft be required to sell a stripped-down, low-cost version of Windows® so computer manufacturers can load their machines with other web browsers, media players, and so on. Under such an arrangement, Microsoft would be free to sell the full version, as well.

In recent testimony, Chairman Bill Gates deemed it "impossible" to comply and declared that he would withdraw Windows from the marketplace before accepting such a remedy. (Reportedly, his nose grew nearly two inches during the testimony.) Another section of the dissenting states' proposed remedy would require Microsoft to provide notification if it knowingly sells software that interferes with the performance of other vendors' products. Chairman Gates also rejected that concept.

In June 2001, the Bush administration reached an antitrust settlement with Microsoft, but the District of Columbia and nine states declared that the settlement was not sufficient to restore competition and protect against potential Microsoft monopolies in handhelds, set-top boxes, and server operating systems. **NV**

IsoPod™ New First Class controller cancels old stamps.



New generation micro computer, tiny, and feature packed, yet connectorized so you can get to the good stuff! A wonderful motion control board.

Plugs into existing stamp sockets w/ option adapter

Feature for feature, the stamps are licked.

Feature	IsoPod™	Basic X-24 TM	Basic Stamp 2(R)	Basic Stamp SX(R)
I/O Lines	16 + 12 PWM + 8 A/D + SPI + CAN...	16 +	16	16
FLASH/EEPROM	64KBytes Prog. 8KBytes Data Flash	32KBytes EEPROM	2KBytes EEPROM	(2K X 8) = 16K
RAM	1KBytes Prog. 4KBytes Data	400 Bytes	32 Bytes	96 Bytes
Program Execution	200,000+ Instructions/sec.	65,000 Instructions/sec.	4000 Instructions/sec.	10,000 Instructions/sec.
Program Length	16000+ instructions	8000+ instructions	~500 instructions	~500 instructions/2K
Analog Inputs	12 Bit ADCs (8Ch) separate pins	10 Bit ADCs (8Ch)	Timed R/C	Timed R/C
Multitasking	Yes! Coded w/Re-entrance in mind	Yes (sort of)	No	No
Programming Language	Forth (3rd party C now) (IsoMAX™, Basic, C soon)	Xbasic	Pbasic	Pbasic
Floating Point	Yes	Yes	No	No
Programming Interface	Parallel, Serial, JTAG/OnCE Interactive debugging with board	Parallel and Serial	Serial	Serial
RS232 Serial I/O	Yes, true levels	Yes	Yes	Yes
RS422 Serial I/O	Yes, on separate connector	No	No	No
SPI Interface	Yes, on separate connector w/4 I/O	Hardware, memory	Software	Software
CAN 2.0 A/B Bus	Yes, on separate connector	No	No	No
JTAG/OnCE	Yes, on separate connector	No	No	No
Servo PWM Outputs (Hardware)	12 Ch, on separate servo oriented connector, independent or 2per complementary pairs, 15-bit counter w/resolution to 25ns	2 Ch	Software	Software
Quadrature Decoder Inputs (Hardware)	2 Ch, Decoder logic, 32-bit Position Counter, 16-bit Revolution Counter, up to 40 MHz count rate	No	No	No
Motor Control	Up to 2 3-phase Brushless DC prog. complementary PWM w/dead time, or 12 independent h/w servo ch.	2 PWM	(PWM software)	(PWM software)
General Purpose Timers	2 Quads w/4 16-bit Timers each, Cascadable, Input Capture, Output Compare, Up/Down	Three	One	One
On-Board LEDs	3 (Red, Yellow & Green)	2 (Red & Green)	No	No
Package	1.2"x3", 24-pin DIP connection w/ribbon or module adapter	24-pin DIP module	24-pin DIP module	24-pin DIP module

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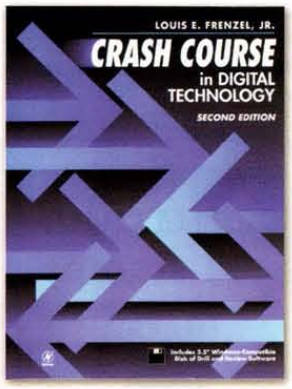
Crash Course in Digital Technology

Second Edition by Louis E. Frenzel, Jr.

$44.99

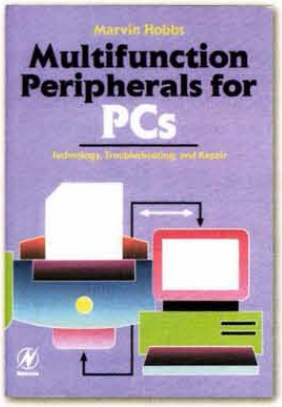


Crash Course in Digital Technology teaches the basics of digital electronics theory and circuits in an easy-to-understand format. Each chapter includes learning objectives, clear explanations and examples, and an end-of-chapter self-quiz. The drill-and-review software included with the book allows learners to test themselves on the contents of each chapter, providing a second reinforcement of the material. A final chapter teaches the basics of troubleshooting digital circuits.

Multifunction Peripherals for PCs

Technology, Troubleshooting and Repair by Marvin Hobbs

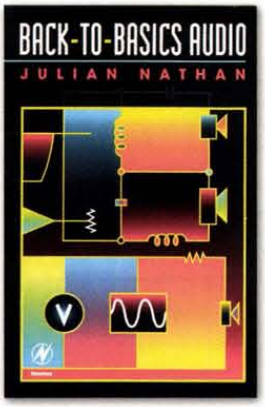
$34.99



Multifunction devices combine the essentials of a fax machine, printer, scanner, and copier into one peripheral for small and home offices. As the market for this equipment grows, the need for skilled repair and maintenance increases. Unfortunately the service documentation supplied by the manufacturers is completely inadequate making the repair jobs even harder and more expensive. Marvin Hobbs teaches you how multifunction peripherals work in theory and in practice with lots of hands-on examples and important troubleshooting and repair tips you don't want to miss.

Back-to-Basics Audio by Julian Nathan

$44.99



Back-to-Basics Audio is a thorough, yet approachable handbook on audio electronics theory and equipment. The first part of the book discusses electrical and audio principles. Those principles form a basis for understanding the operation of equipment and systems, covered in the second section. Finally, the author addresses planning and installation of a home audio system.

* Notes on home theater systems, speaker placement, and calibration
* System planning, diagram analysis, and signal processing
* Easy introduction to practical audio, acoustics, and electrical theory

Crash Course in PC and Microcontroller Technology

by Louis E. Frenzel, Jr.

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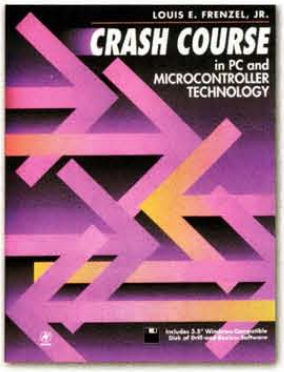

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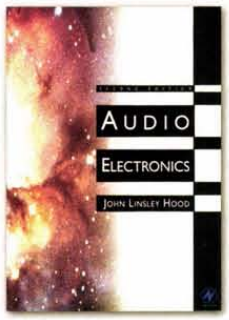

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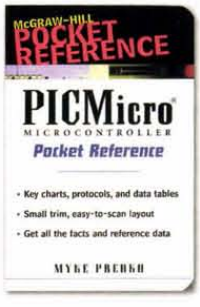

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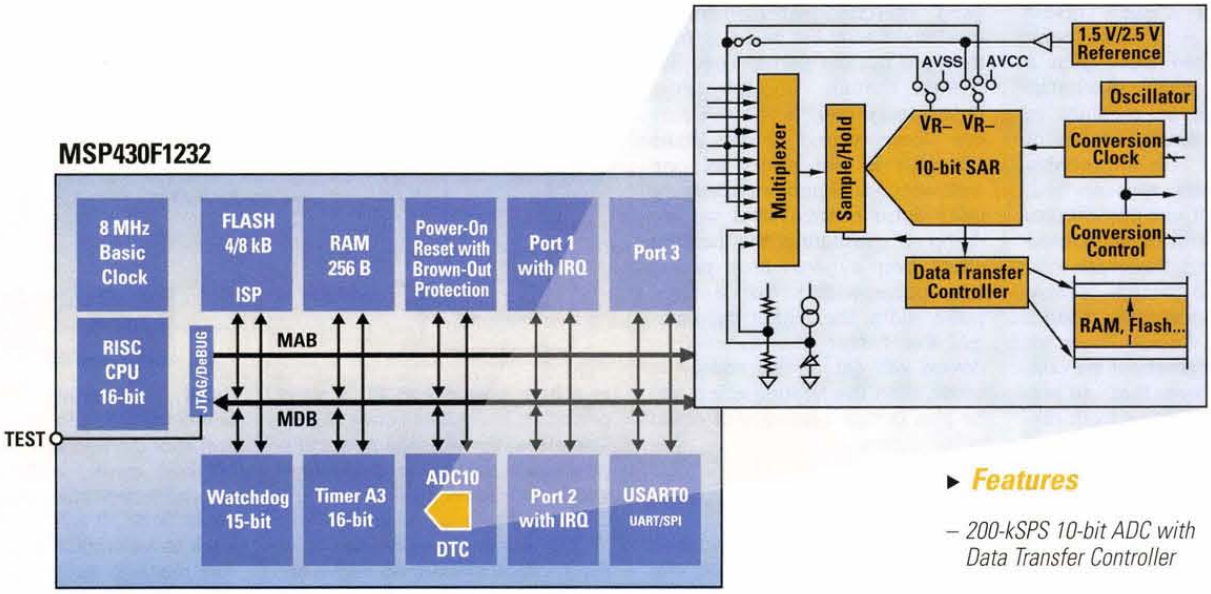

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by Stanley York

Laser Insight

Last month, I described the construction of one of the simplest gas lasers around — the nitrogen laser. This pulsed laser uses a high-voltage arc discharge through a gaseous medium to produce high-intensity flashes of ultraviolet light. This is probably the simplest laser ever devised, since it does not use any mirrors (adding one mirror does increase the energy output, however).

In this case though, simple laser does not necessarily mean it is easy to make it work. There are a number of things about the construction of the laser that can prevent proper laser action from taking place, and I covered some of these last month, so I will not repeat them here. At the time of this writing, the article hadn't yet been published, so I don't know if anyone out there actually tried to build it. I hope they did, and were successful in making it work.

This month, I am going to lightly introduce a few more pulsed systems, and end with a discussion on the dye laser I mentioned last month.

All pulsed lasers have one thing in common. They all put out high peak powers, but using relatively little energy (when compared to a CW system). The reason for this is the time period involved, and the round-trip gain that exists during the flashlamp pulse.

Continuous wave lasers emit a continuous beam of energy. Power is energy divided by time. In the discussion on Joules in the March '02 issue of *Nuts & Volts*, I tried to illustrate how energy and power are related.

Energy and power are often used interchangeably in many everyday situations when, in fact, they are not the same. They are related though, through time. One watt (power) is the same as one Joule/second or one Joule (energy) is the same as one watt/second. When we measure laser pulse energy, what we are doing is measuring the heating effect over a given time period (the pulse width). For a fixed pulse width, the higher the energy, the hotter the measuring device will get. If the energy is small, then the heating effect will be less (when dealing with equal pulse widths).

Table 1.
Common laser dyes

Dye type	Center Wavelength (nM)
Polyphenyl 1	380
Coumarin 2	450
Coumarin 47	470
Coumarin 102	480
Coumarin 30	515
Rhodamine 6G	590
Rhodamine B	610

Solid-state lasers

The Cr:Ruby laser I described a couple of issues back was the first laser system ever demonstrated, anywhere. It was also the first solid-state laser. Solid-state lasers use a solid host medium that is usually some kind of glass or crystal structure. The dopant (the lasing medium) is the ingredient that determines the wavelength of the light produced by the laser. Other common types are Nd:YAG, Nd:YLF, Nd:Glass, Ti:Sapphire, and a number of other less well-known materials. All these materials can be used in a pulsed mode using a flashlamp, and some of them can be used in a continuous wave (CW) mode using an arclamp.

One of the most serious concerns with any CW mode laser system is how to keep the lamp and laser rod at a stable temperature. In a CW laser, the lamp is continuously trying to excite the laser rod. In doing so, the lamp can produce tens (sometimes many tens) of kilowatts of heat that has to be removed. This amount of power, if not removed continuously, would melt the lamp in a couple of seconds. For this reason, all CW lamp pumped laser systems are water-cooled. For further reference, see the article on the Nd:YAG laser (*Nuts & Volts*, Nov. '01).

In a pulsed laser, however, the requirements for heat removal are much less, since the lamp is only at a high power level for a short period (a few milliseconds, tops). Therefore, the average power dissipation in the pump chamber is very much lower than in the CW counterpart.

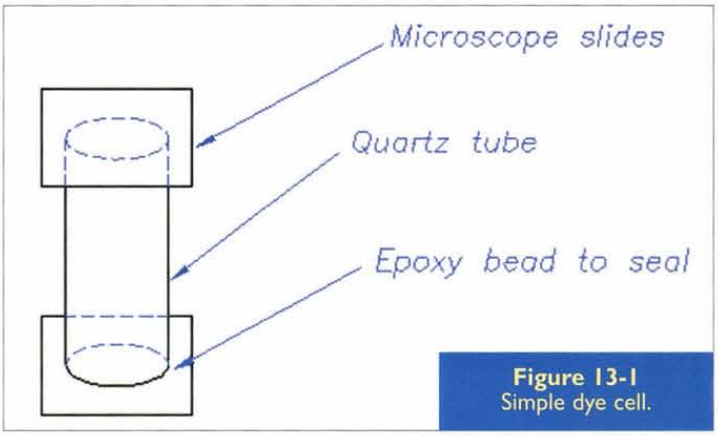

Figure 13-1
Simple dye cell.

For similar reasons, not all of the crystals mentioned above are suitable for CW applications. Nd:YAG and Nd:YLF are very good heat conductors, so they can be cooled effectively through water circulation around the pump chamber. Of course, using water around a high-voltage lamp is not something to be taken lightly, and only de-ionized water can be used (DI water has very high volume resistivity).

Nd:Glass and Cr:Ruby in contrast, cannot be run in a CW mode, but only in pulsed mode because of their much lower heat transfer rate. Because of the low thermal conductivity of these materials, there is a pronounced delay between the heat input to the rod (when the lamp fires) and the heat removal (when the rod gives up the heat to the surrounding water, and returns to its stable temperature). This causes a pronounced thermal gradient across the diameter of the rod that causes peculiar lensing effects within the rod. Because of the lensing effects, there are strict limitations on how fast Nd:Glass and Cr:Ruby lasers can be fired.

As an indication of the effects, try to visualize the following. A HeNe laser is aligned through a Nd:Glass rod, for instance, and a mark is made where the transmitted HeNe beam hits the opposite wall. The lamp is then fired a few times in rapid succession. The HeNe beam will be seen to wander several spot diameters away from the original mark, and will move around erratically while the rod cools down. It will, of course, go back to its original spot when the rod reaches its stable temperature.

The apparent movement of the HeNe is caused by the thermal gradient across the rod, making the rod act like a very thick, small diameter lens. This may seem an oddity, but it can cause serious problems in large, high-power systems. A high-energy pulse can cause such a sharp (and severe) thermal distortion in the rod that the laser beam may begin to focus inside the laser rod (the reflections from the resonator mirrors).

Continued use under these conditions can cause microscopic cavitation in the glass, that acts as a focal point for further damage. The cracks thus formed propagate down the length of the rod, rendering it useless. High-energy pulsed Q-switched lasers are particularly prone to damage through this mechanism, and careful attention has to be given to reflections from external lenses and mirrors, and heat-related lensing effects.

Surgical lasers using Cr:Ruby crystals for tattoo removal, typically use pulse widths of 20-40 nSec width (a Q-switched pulse). The energy in the pulse may not be high (maybe 0.5-1.5 Joules), but the peak power (that actually destroys the pigmented cells) may easily reach 60 megawatts! But because the pulse only lasts

for a few tens of nanoseconds, the patient feels very little discomfort (like hot candle wax dropping on the skin). After a few days, the dead skin cells turn white and flake away, as they are replaced by new cells.

Gas lasers

Among the gas lasers, most gases can be run either CW or pulsed, but nitrogen lasers can only be pulsed, as we found out last month. Copper-vapor lasers are also pulsed, but they can run at high pulse repetition frequencies (PRF), so that the output appears as a continuous beam. These lasers run at furnace temperatures high enough to form a metallic vapor that acts as the laser medium.

Another gas laser that has become a valuable tool in micro machining the last few years is the excimer (a contraction of 'excited dimer') laser. The term excimer describes a relatively small group of pulsed gas lasers that can produce very high peak powers at several different wavelengths, usually in the blue/ultraviolet part of the spectrum.

The common thread between them is in the 'dimer' part of the name. This refers to a diatomic molecule that is bound only in the excited state, whereas its electronic ground state is only loosely bound. Present excimer lasers commonly use a krypton fluoride/helium mix in a pump chamber similar to the nitrogen laser. In this case though, the gas pressure is usually a few atmospheres. These lasers typically use an arc discharge similar to the nitrogen laser, but at much higher levels (10E8 to 10E9 watts).

Liquid lasers

What's that you say, you never heard of a liquid laser?

Oh yes, there are such things. In fact, one of my first projects when I came to the US over 20 years ago was to build a liquid laser. Actually, what I had to do was to reproduce a dye laser setup for an ongoing patent investigation. The device I built was a flashlamp-pumped dye tube that ran parallel to the flashlamp, and in close proximity.

The whole thing was then surrounded by a cylindrical reflector made of polished aluminum. In the future, I will describe this in more detail, because it is an interesting laser, that is easy to build, and what's interesting is that many colors can be obtained from it. It can be 'tuned' as we say, across a good portion of the visible spectrum. This is one version of a dye laser but there are many more, and a simple dye cell you can use with your nitrogen laser can be made by anyone at home, using commonly-available materials. I will describe this before the end of this column.

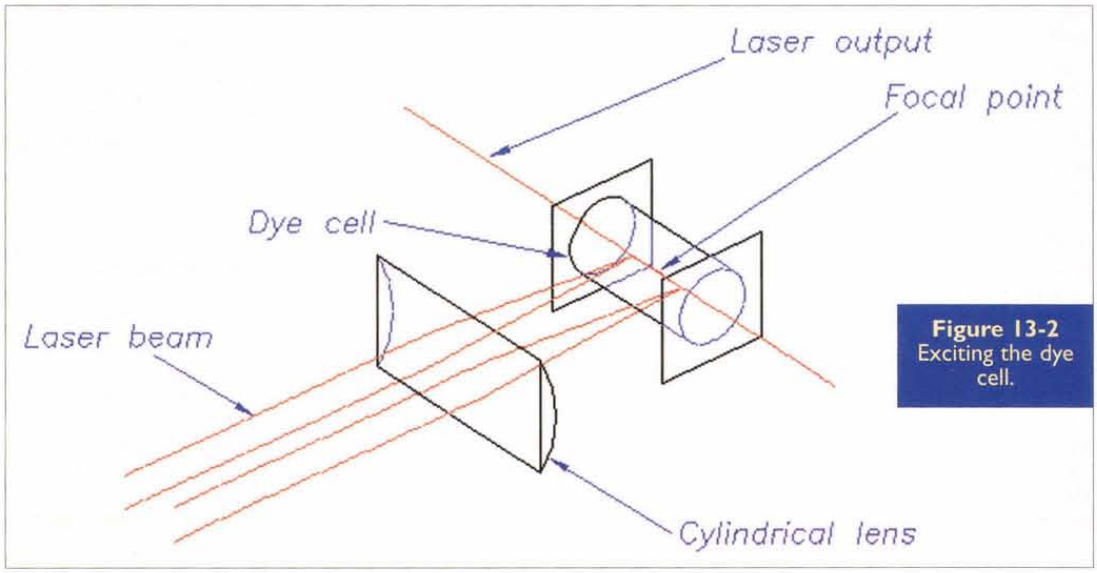

Figure 13-2
Exciting the dye cell.

Micro machining

The lasers described above are all capable of producing high peak powers in a very short pulse. A big advantage of this type of pulse is that it can ablate the surface of target material, rather than heat the surface to melting point. In a pulsed laser, the pulse width may be anything between several milliseconds in length, down to a few tens of nanoseconds, as we saw a couple of issues back. In pulsed gas lasers of the excimer type, the pulses are very short (sometimes called ultrashort or ultrafast pulses). These pulses are sometimes measured in picoseconds or femtoseconds (10E-12 or 10E-15 seconds).

If you read any technical journals, or perhaps some other electronics hobbyist periodicals, you have no doubt seen pictures of holes drilled through a human hair. A popular picture that has been around for many years now shows square holes about 0.0003" on a side, drilled about 0.001" apart through a hair about 0.001" in diameter. The hair surrounding the holes is unaffected by the drilling process.

Another photograph recently going around shows a microscopic chain and gearwheel assembly. The photo shows what looks like a transmission chain and gear wheels off a motorcycle. In fact, the chain and gears are made of polysilicon. The pitch on the chain is only 50 microns (0.05mm or 0.002 inch). The height of the mechanism is 13.3 microns (0.013mm or 0.0005 inch), and there are 50 links in the chain. Such mechanisms as this are being touted as future micro robots, potentially able to be injected into the human body, under control, to perform internal surgery without an incision.

Seeing these examples of micro machining, you have to wonder how this is possible.

The focused spot size of a laser beam depends on a couple of things. First, the beam has to be of low divergence. We discussed divergence some time ago, but if you missed the explanation, divergence tells us how a laser beam spreads after it leaves the laser. The smaller the divergence figure, the less the beam spreads, and the tighter the focused spot size can be made. Second, spot size is also dependent on the wavelength of the light, and the shorter the wavelength, the smaller the focused spot. With the excimer laser described above, the wavelength is well into the ultraviolet, and with tight control on the divergence that is possible on this type of laser, a very tightly focused spot can be produced.

With the very fast, finely focused pulses from the lasers mentioned above, and the high peak powers they produce, this kind of machining process becomes possible. With a conventional pulsed laser, a lot of energy is used to heat the surface material to melting point, whereupon it either blows away through vapor pressure, or is blown away by a pressurized assist gas. With very fast pulsing, the surface reaction is somewhat different. The most common types of excimer laser emit light in the deep UV end of the spectrum.

UV light has some peculiar properties, and can actually break chemical bonds without exposing the surroundings to elevated temperatures. Surface material is broken down and ablated from the body without heating. Excimer lasers can produce high power pulses of UV light in pulse widths up to about 50nSecs, and at a PRF of one kHz or more.

Simple dye cell

If you built the nitrogen laser last month, the remainder of this article will be spent discussing a simple dye cell you can add to your laser collection. Figure 13-1 shows a simple dye cell made of quartz glass, and with microscope slides cemented on the ends. You can use epoxy to seal the slides to the tube, but make sure to get the tube as square and straight as possible in order to expose as little adhesive as possible to the dye liquid.

Set up the dye cell as shown in Figure 13-2, and use a cylindrical lens to focus the output of the nitrogen laser into the dye liquid. When the laser is fired, the cylindrical lens will cause the laser beam to focus into a line, rather than to a point, as in a spherical lens.

The high intensity of the UV light at the focal point causes the dye to become "superradiant" and emit laser light of a different wavelength (depending on the dye type and concentration) along the line of focus. The secondary

emission from the dye is output at both ends of the cell. Again, a mirror may be used at one end of the cell instead of a plain slide to concentrate the light, and emit from only one end of this laser, as we saw in the nitrogen laser last month.

There are many dye types available for this type of laser study, and a few are listed in Table 1, with their approximate center wavelength. As you will see, the wavelength range is from blue (380nM) through green (480-515nM) to yellow (590nM) to orange/red (610nM). These dye/solvent solutions are for excitation using the nitrogen laser described in the last couple of issues.

For other pump sources, a different solvent may be required for optimum results. If you have an alternative pump source, please email me and I will compile a list of dyes and solvents for your particular use. There will be no charge, but please include details of your set-up, including laser type, pulse width, etc. Take care when mixing the dyes, and use a very small amount of dye when making a solution. Typically, only a few milligrams of dye are used per liter of solvent. For the dye cell described here, you will need much, much less than a milligram. If you purchase dye from a commercial supplier, they will be able to tell you the concentration of dye to solvent.

Some solvents work better than others for a given dye, and for all the dyes listed, methanol will work. You may also try ethanol, ethylene glycol, or glycerol. Isopropyl alcohol will dissolve these dyes also, but is not photochemically stable, and is not recommended. When working with these chemicals, strictly follow the recommendations of the supplier. Many of the dyes are very toxic, and some can be absorbed through the skin. Similarly, many of the solvents used in dye lasers are toxic, some carcinogenic. The solvents suggested here are probably the safest.

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These suppliers normally sell their products in one gram lots or more, and generally to laser manufacturing companies or universities. These companies are just a couple I found while surfing the web. There are many other dye suppliers, too numerous to list here.

Well, I've about run out of space again, so I'm off to start work on the next issue. As always, if you have any comments about this column, or suggestions for future articles, please let me know by email at stanley.york@att.net, or through this fine magazine. **NV**

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Reader Feedback

Editor's Note: Last month, Fred Blechman's article on "Build a Radio Frequency Field Strength Meter" listed LNS Technologies as the source. They have a new address, which is: P.O. Box 11831, Pleasanton, CA 94588, 925-600-1775.

News Bytes

HAM RADIO INDUSTRY GROUP OFFICIALLY FORMED

Submitted by Gordon West

The licensed United States amateur radio population is around three-quarter million "hams." Scanner and shortwave listeners might be double this figure, and the popular GMRS, Family Radio Service, and new multi-use radio service have attracted well over one million operators. Prominent non-commercial radio user groups like the Personal Radio Steering Group (Ann Arbor, MI), and the American Radio Relay League (Newington, CT) well represent the interest of the users, but some radio industry officials feel there may be a lot more that the radio industry may do to help spread the word about these sometimes understated capabilities of each radio service in an emergency and for radio safety out on the highways or trails.

"I don't see any amateur radio promotions in RV magazines, nor in aviation and marine magazines, nor in law enforcement journals," comments William Alber WA6CAX, a ham radio instructor and reserve airborne public safety officer.

"Our city's Citizens Emergency Response Team (CERT) program encourages a close relationship with licensed amateur operators, plus our CERT members are trained on how to use FRS equipment, scanners, and GMRS radios," adds Ms. Teri Durnall, City of Costa Mesa.

Bob Leef, Public Relations Chairman for REACT International, reminded me that the REACT organization was developed in the 1950s by a radio industry CB equipment manufacturer, Hallacrafters.

On April 5th, 2002, during an informal amateur radio industry meeting held in Milwaukee, WI, hosted by ham radio mega-dealer, Amateur Electronics Supply, a lengthy discussion ensued on

Continued on Page 63

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TEKTRONIX 1101 Accessory Power Supply, for FET probes $175.00
TEKTRONIX A6902B Voltage Isolator, DC-20 MHz, 20 mV-500 V/division $500.00
TEKTRONIX P6201 900 MHz 1X/ 10X/ 100X FET Probe $400.00
TEKTRONIX P6202 500 MHz 10X FET Probe $150.00

WAVEFORM GENERATORS

FUNCTION GENERATORS

HP 3324A 21 MHz Function Synthesized Generator, HPIB $2250.00
HP 3325A-001 21 MHz Synthesizer/Function Generator, OCXO ref. $1100.00
HP 3325A-002 21 MHz Synthesizer/Function Generator, high voltage $1200.00
HP 3325B-002 Synthesizer/ Function Generator, 1 uHz-21 MHz, HPIB $4000.00
TEKTRONIX AWG5102 Arb. Waveform Gen., 20 MS/s, 12 bits, 50 ppm synthesis <1MHz $650.00
TEKTRONIX AWG5102-opt.2 Arbitrary Waveform Generator, dual channel option $800.00
TEKTRONIX DD501 Digital Delay & Burst Gen., for function & pulse gen's $200.00
TEKTRONIX FG5010 Programmable 20 MHz Function Generator, TM5000 series $600.00
TEKTRONIX FG502 11 MHz Function Generator, TM500 series $275.00
TEKTRONIX FG503 3 MHz Function Generator, TM500 series $250.00
TEKTRONIX RG501 Ramp Generator, TM500 series $175.00
WAVETEK 288 20 MHz Synthesized Function Generator, GPIB $650.00

PULSE GENERATORS

BERKELEY NUC. 7085B Digital Delay Gen., 0-100 mS, 1 nS res.,5 Hz-5 MHz $400.00
HP 214B 10 MHz Pulse Generator, up to 50V/ 50 Ohms $1200.00
HP 214B-001 10 MHz Pulse Generator, pulse counting option $1400.00
HP 8007B 100 MHz Pulse Generator $450.00
HP 8012B 50 MHz Pulse Generator, variable transition time $600.00
HP 8013A 50 MHz Dual Output Pulse Generator $500.00
HP 8013B 50 MHz Dual Output Pulse Generator $600.00
HP 8112A 50 MHz Pulse Generator, HPIB $3000.00
HP 8116A-001 50 MHz Pulse/Function Generator, burst & log sweep option $3500.00
TEKTRONIX PG502 250 MHz Pulse Generator, TM500 series $500.00
TEKTRONIX PG508 50 MHz Pulse Generator, TM500 series $350.00

VOLTAGE & CURRENT

VOLTMETERS

FLUKE 845AR High Impedance Voltmeter / Null Detector $350.00
HP 3456A 6-1/2 digit Voltmeter, HPIB $450.00
HP 3457A 7-1/2 digit Voltmeter, HPIB $1000.00
HP 3478A 5-1/2 digit Multimeter, HPIB $450.00
KEITHLEY 181 6-1/2 digit Nanovoltmeter, 10 nV sensitivity, GPIB $675.00
TEKTRONIX DM5010 4-1/2 digit Multimeter, TM5000 series $300.00
TEKTRONIX DM501A 4-1/2 digit Multimeter, TM500 series $225.00

CALIBRATION

FLUKE 510A AC Reference Standard, 10 VRMS, 0-10 mA $450.00
FLUKE 5220A Transconductance Amplifier, DC-5 kHz, 0-20 A $1250.00

VOLTAGE SOURCES

HP 6114A Precision Power Supply, 0-20 V 2 A/ 0-40 V 1 A $650.00
HP 6115A Precision Power Supply, 0-50 V 0.8A/ 0-100 V 0.4A $650.00
TEKTRONIX PS5004 Precision Power Supply, 0-20 V 0-300 mA, 1 mV res. $950.00

CURRENT METERS & SOURCES

HP 4140B DCV Source / Picoammeter, HPIB $3500.00
HP 6177C DC Current Source, to 50 V, 500 mA $500.00
HP 6181C DC Current Source, to 100 V, 250 mA $500.00
KEITHLEY 225 Current Source, 0.1 uA-100 mA, 10-100 V compliance $450.00
TEKTRONIX P6022 AC Current Probe, 935 Hz-120 MHz, 6 A peak $250.00
VALHALLA 2500 AC/DC Current Calibrator, 2 uA-2 A, DC-10 kHz $500.00

IMPEDANCE & COMPONENT TEST

L.C.R.

BOONTON 62AD 1 MHz Inductance Meter, 2-2000 uH $500.00
BOONTON 72BD 1 MHz Capacitance Meter, 2-2000 pF f.s. 3 digits $800.00
BOONTON 72C 1 MHz Capacitance Meter, 1-3000 pF f.s. analog $800.00
GENERAL RADIO 1658 RLC Digibridge, 120 Hz / 1 kHz $1000.00
HP 4262A 3-1/2 digit LCR Meter, 120 Hz/ 1 kHz/ 10 kHz $950.00
HP 4274A 5-1/2 digit LCR Meter, 100 Hz-100 kHz, HPIB $3250.00

STANDARDS

E.S.I. SR-1 Standard Resistor, various values $125.00
E.S.I. SR1010 Resistance Transfer Standards, 1 Ohm-100 K/step $500.00
GENERAL RADIO 1406-series Standard Air Capacitors, GR900 connector, 0.1% acc $275.00
GENERAL RADIO 1409-series Standard Capacitors, 0.001-1.0 uF values available $150.00
GENERAL RADIO 1433-J 4-Decade Resistor, 0-11.11 Kilohms, 1 Ohm steps $150.00
GENERAL RADIO 1433-K 4-Decade Resistor, 0-1.11 Kilohms, 0.1 Ohm steps $150.00
GENERAL RADIO 1433-P 5-Decade Resistor, 0-1.1111 Megohms, 10 Ohm steps $200.00
HP 4440B Decade Capacitor, 40 pF-1.2 uF $750.00

HI & LO RESISTANCE

HP 4329A High Resistance Meter, 500 Kilohms-2x 10e16 Ohms $875.00

T.D.R.

TEKTRONIX 1503B-03,04 TDR, 0-50,000 feet; chart rec. & battery options $2500.00

POWER SUPPLIES

SINGLE OUTPUT

HP 6002A-001 0-50 V / 0-10 A / 200 Watts max. Supply, HPIB $650.00
HP 6011A 0-20 V/ 0-120 A/ 1000 Watts max., CV/CC Supply $1800.00
HP 6028A 0-60 V/ 0-10 A/ 200 Watts max. Autoranging Supply $1000.00
HP 6033A 0-20 V/ 0-30 A/ 200 Watts max. Supply, HPIB $1200.00
HP 6038A 0-60 V/ 0-10 A/ 200 Watts max Supply, HPIB $1200.00
HP 6203B 0-7.5 V 0-3 A CV/CC Power Supply $175.00
HP 6205C Dual Power Supply, 0-40 V 300 mA/ 0-20 V 600 mA $300.00
HP 6207B 0-160 V 0-200 mA CV/CC Power Supply $200.00
HP 6263B 0-20 V 0-10 A CV/CC Power Supply $375.00
HP 6266B 0-40 V 0-5 A CV/CC Power Supply $375.00
HP 6267B 0-40 V 0-10 A CV/CC Power Supply $550.00
HP 6271B 0-60 V 0-3 A CV/CC Power Supply $375.00
HP 6274B 0-60 V 0-15 A CV/CC Power Supply $650.00
HP 6384A 4.0-5.5 V at 8 A CV/CL Power Supply $125.00
HP 6443B 0-120 V 0-2.5 A CV/CC Power Supply $375.00
HP 6515A 0-1600 V 5 mA CV/CL Power Supply $275.00
HP 6525A 0-4000 V 0-50 mA CV/CC Power Supply $650.00
HP 6552A 0-20 V 0-25 A CV/CC Power Supply $1000.00
HP 6643A 0-35 V 0-6 A CV/CC Power Supply, HPIB $1200.00
HP 6651A 0-8 V 0-50 A CV/CC Power Supply, HPIB $1500.00
HP 6652A 0-20 V 0-25 A CV/CC Power Supply, HPIB $1875.00
KEPCO ATE 36-8M 0-36 V 0-8 A CV/CC Power Supply $300.00
SORENSON SRL 20-12 0-20 V 0-12 A CV/CC Power Supply $350.00
SORENSON SRL 60-8 0-60 V 0-8 A CV/cc Power Supply $450.00

MULTIPLE OUTPUT

HP 6228B Dual Power Supply, 0-50 V 0-1 A, CV/CC $375.00
HP 6236B Triple Output Supply, +/-20 V 0.5A & 0-6 V 2.5 A $375.00
HP 6237B Triple Output Supply, +/-20 V 0.5 A & 0-18 V 1 A $375.00
HP 6253A Dual Power Supply, 0-20 V 0-3 A, CV/CC $375.00
HP 6255A Dual Power Supply, 0-40 V 0-1.5 A, CV/CC $375.00
HP 6627A Quad Output Power Supply, 0-20 V 2A or 0-50V 800mA $2750.00
TEKTRONIX PS503A Dual Power Supply, TM500 series $200.00

MISCELLANEOUS

ACME PS2L-500 Programmable Load, 0-75 V / 0-75 A / 500 Watts max $350.00
ACME PS2L-500 Programmable Load, 0-75 V/ 0-75 A/ 500 Watts max. $300.00
HP 6826A Bipolar Power Supply / Amplifier, +/-50 V 1 A max. $900.00
HP 6827A Bipolar Power Supply / Amplifier, +/-100 V +/-500 mA $900.00
KEPCO BOP 50-2M Bipolar Amplifier/ Power Supply, to 50 V, 2 A $400.00
TRANSISTOR DEV DAL-50-15-100 Programmable Load, 0-50 V, 0-15 A, 100 Watts max. $200.00

TIME & FREQUENCY

UNIVERSAL COUNTERS

HP 5314A 100 MHz/ 100 nS Universal Counter $175.00
HP 5315A 100 MHz/ 100 nS Universal Counter $350.00
HP 5315A-003 100 MHz/ 100 nS Counter, 1 GHz C-channel $450.00
HP 5315B 100 MHz/ 100 nS Universal Counter $375.00
HP 5316A 100 MHz/ 100 nS Universal Counter, HPIB $450.00
PHILIPS PM6672/ 411 120 MHz/ 100 nS Universal Counter, 1 GHz C-channel $300.00
TEKTRONIX DC5004 100 MHz/ 100 nS Counter/ Timer, TM5000 series $200.00
TEKTRONIX DC5009 135 MHz/ 10 nS Counter/ Timer, TM5000 series $350.00
TEKTRONIX DC503A 125 MHz/ 100 nS Universal Counter, TM500 series $250.00
TEKTRONIX DC509 135 MHz/ 10 nS Universal Counter, TM500 series $275.00

FREQUENCY COUNTERS

EIP 548A-06 26.5 GHz Frequency Counter & mixers for 26-60 GHz $3950.00
EIP 578-02,05 26.5 GHz Source Locking Counter, GPIB& power meter $2750.00
HP 5342A 18 GHz Frequency Counter $900.00
HP 5343A-001 26.5 GHz Frequency Counter, OCXO reference $2500.00
HP 5345A/55A/56B 26.5 GHz CW/ Pulse Frequency Counter $3500.00
HP 5352B-010 40 GHz Frequency Counter, OCXO reference option $7500.00
HP 5384A 225 MHz Frequency Counter, HPIB $450.00
XL MICROWAVE 3401 40 GHz Source Locking Frequency Counter, GPIB $5500.00

STANDARDS

HP 105B Quartz Oscillator, 0.1/ 1.0/ 5.0 MHz, battery pwr. $1100.00

AUDIO & BASEBAND

SPECTRUM ANALYSIS

HP 3586C Selective Level Meter, 50 Hz-32.5 MHz, 50& 75 Ohms $1000.00

DISTORTION ANALYZERS

HP 8903A Audio Analyzer, 20 Hz-100 kHz, HPIB $1200.00
HP 8903B-001,010,053 Audio Analyzer, 20 Hz-100 kHz, HPIB $1850.00
HP 8903E Audio Analyzer, 20 Hz-100 kHz, HPIB $1650.00

RMS VOLTMETERS

FLUKE 8922A True RMS Voltmeter, 180 uV-700 V, 2 Hz-11 MHz $450.00

OSCILLATORS

TEKTRONIX SG502 Sine/ Square Osc., 5 Hz-500 kHz, 70 dB step atten., TM500 ..... $200.00
TEKTRONIX SG505-opt.2 Oscillator, 10 Hz-100 kHz; IM test & 50/150/600 Ohms $800.00
WAVETEK 98 1 MHz Synthesized Power Oscillator, GPIB $750.00

MISCELLANEOUS

HP 3575A Phase-Gain Meter, 1 Hz-13 MHz, single display $600.00
HP 3575A-001 Phase-Gain Meter, 1 Hz-13 MHz, dual display $750.00
HP 467A Power Amplifier $375.00
KROHN-HITE 3200 High Pass / Low Pass Filter, 20 Hz-2 MHz $275.00
KROHN-HITE 3202 Dual HP/LP/BP/BR Filter, 20 Hz-2 MHz $450.00
ROCKLAND 852 Dual Highpass/ Lowpass Filter, 0.1 Hz-111 kHz $650.00
TEK AM502 1 MHz Differential Amplifier, TM500 series $450.00

RF & MICROWAVE

SPECTRUM ANALYZERS

HP 11517A/19A/20A Mixer Set, 18-40 GHz, for HP 8555A / 8569A $475.00
HP 11970A WR28 Harmonic Mixer, 26.5-40 GHz $1000.00
HP 11970K WR42 Harmonic Mixer, 18.0-26.5 GHz $1000.00
HP 11970Q WR22 Harmonic Mixer, 33-50 GHz $1400.00
HP 11970U WR19 Harmonic Mixer, 40-60 GHz $1600.00
HP 11971A WR28 Harmonic Mixer, 26.5-40 GHz,for 8569B $800.00
HP 11971K WR42 Harmonic Mixer, 18.0-26.5 GHz, for 8569B $800.00
HP 11974A WR28 Preselected Mixer, 26.5-40 GHz $8000.00
HP 11974U WR19 Preselected Mixer, 40-60 GHz $8500.00
HP 11975A L.O. Amplifier, 2-8 GHz $1400.00
HP 8562A Spectrum Analyzer, 1 kHz-22 GHz, 100 Hz min.res. Bw $16000.00
HP 85640A Tracking Generator, 300 kHz-2.9 GHz, or HP 8560 series $4000.00
TEKTRONIX WM782V WR15 Harmonic Mixer, 50-75 GHz $1500.00

NETWORK ANALYZERS

HP 11650A Network Analyzer Accessory Kit $500.00
HP 11650A Network Analyzer Accessory Kit, APC7 ..... $600.00
HP 11665B Modulator, 0.15-18 GHz, for HP 8755/6/7 ..... $250.00
HP 11665B Modulator, 0.15-18.0 GHz, for HP 8755/6/7 ..... $250.00
HP 3577B Network Analyzer, 5 Hz-200 MHz $9500.00
HP 4191A RF Impedance Analyzer, 1-1000 MHz, 1 milliohm-100 Kilohms $3750.00
HP 4193A Vector Impedance Meter, 400 kHz-110 MHz, 10 Ohms-100 K $4500.00
HP 8502B 75 Ohm Transmission/ Reflection Test Unit, 0.5-1300 MHz $675.00
HP 85044B 75 Ohm Transmission/ Reflection Test Unit, 300 kHz-2 GHz $1250.00
HP 85054A Type N Calibration Kit, for HP 8510 series $1800.00
HP 8717B-001 Transistor Bias Supply $350.00
HP 8751A-001,002 Network Analyzer, 5 Hz-500 MHz $12500.00
HP 8756A Scalar Network Analyzer, HPIB $1375.00
HP R85026A WR28 Detector, 26.5-40 GHz, for HP 8757 series $1200.00

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SIGNAL GENERATORS

FLUKE 6060B/AK Signal Generator, 0.1-1050 MHz, 10 Hz res. $1250.00
FLUKE 6060B-130,830 Signal Generator, 0.1-1050 MHz, 10 Hz res., GPIB $1600.00
GIGATRONICS 1018 Signal/Sweep Gen., 0.05-18 GHz, 1 kHz res., +8 dBm $5000.00
GIGATRONICS 600/ 6-12 Synthesized Source, 6-12 GHz, 1 MHz res., GPIB $1500.00
GIGATRONICS 6000/ 8-16 Synthesized Source, 8-16 GHz, 1MHz res., GPIB $2250.00
GIGATRONICS 6061A-830 Signal Generator, 0.1-1050 MHz, 10 Hz res., AM, FM, GPIB $1900.00
HP 11707A Test Plug-in, for HP 8660 series $400.00
HP 11720A Pulse Modulator, 2-18 GHz, 80 dB on/off ratio $450.00
HP 8642M Signal Generator, 0.1-2100 MHz, 1 Hz res., HPIB $3750.00
HP 8656B-001 Signal Generator, 0.1-990 MHz, 10 Hz res., HPIB, OCXO $2750.00
HP 8657A Signal Generator, 0.1-1040 MHz, 10 Hz res., AM, FM, HPIB $3000.00
HP 8660C/603A/633B Signal Generator, 1-2600 MHz, 1 or 2 Hz res., AM, FM $3250.00
HP 8660D/86603A-002 Signal Generator, 1-2600 MHz, 1 or 2 Hz res., phase modulation $6000.00
HP 8671A Signal Gen., 2.0-6.2 GHz, 1 kHz res., CW, FM, +8 dBm, HPIB $2750.00
HP 8671B Synthesized Signal Generator, 2-18 GHz $4000.00
HP 8672A Signal Generator, 2-18 GHz, 1-3 kHz res., AM, FM, +3 dBm $4500.00
HP 8672A-008 Signal Generator, 2-18 GHz, 1-3 kHz res., AM, FM, +8 dBm $5000.00
HP 8673C Signal Gen., 0.05-18.6 GHz, 1 kHz res., AM, FM, Pulse, HPIB $14000.00
HP 8673D-H15 Signal Gen., 0.05-26 GHz, 1 kHz res., AM, FM, HPIB $15000.00
HP 8673H-212 Signal Generator, 2.0-12.4 GHz, 1 kHz res., AM, FM, +8 dBm $8500.00
HP 8673M Signal Generator, 2-18 GHz, 1 kHz res., AM, FM, +8 dBm $9500.00
HP 8683B Signal Generator, 2.3-6.5 GHz, cavity tuned, AM/ WBFM/ Pulse $2250.00
HP 8683D Signal Generator, 2.3-13.0 GHz, cavity tuned, AM/ WBFM/ Pulse $3750.00
HP 8684B Signal Generator, 5.4-12.5 GHz, cavity tuned, AM/ WBFM/ Pulse $2250.00
MARCONI 2019 Signal Generator, 80 kHz-1040 MHz, 10 or 20 Hz res $850.00
WAVETEK 955 Signal Generator, 7.5-12.4 GHz, +7 dBm, AM, FM $750.00
WAVETEK 957 Signal Generator, 12-18 GHz, +7 dBm, AM, FM $750.00

SWEEP GENERATORS

HP 8350B/ 83522A Sweep Oscillator, 10-2400 MHz, +13 dBm levelled $3750.00
HP 8350B/ 83525A Sweep Oscillator, 10 MHz-8.4 GHz, +13 dBm levelled $5000.00
HP 8350B/ 83540A-002 Sweep Oscillator, 2.0-8.4 GHz, 70 dB step atten. $3250.00
HP 8350B/ 83545A-002 Sweep Oscillator, 5.9-12.4 GHz, 70 dB step atten. $3750.00
HP 8350B/ 83570A Sweep Oscillator, 18.0-26.5 GHz, +10 dBm levelled $7000.00
HP 8350B/83570A-H22 Sweep Oscillator, 17-24 GHz, +10 dBm levelled $5000.00
HP 8620C Sweep Oscillator Frame $500.00
HP 86222B-002 RF Plug-in, 10-2400 MHz, +13 dBm, 70 dB step atten. $1250.00
HP 86222B-E69/8620C Sweep Osc. & frame, 0.01-2 GHz & 2-4 GHz bands $1200.00
HP 86240B RF Plug-in, 2.0-8.4 GHz, +13 dBm levelled $450.00
HP 86241A RF Plug-in, 3.2-6.5 GHz, +8 dBm levelled $300.00
HP 86245A RF Plug-in, 5.9-12.4 GHz, +16 dBm unlevelled $350.00
HP 86251A RF Plug-in, 7.5-18.6 GHz, +10 dBm levelled $500.00
HP 86260A RF Plug-in, 12-18 GHz, +10 dBm unlevelled $400.00
HP 86260A-H04 RF Plug-in, 10-15 GHz, +10 dBm unlevelled $400.00
HP 86290B RF Plug-in, 2.0-18.6 GHz, +10 dBm levelled $1500.00
HP 86290C RF Plug-in, 2.0-18.6 GHz, +13 dBm levelled $1750.00
WAVETEK 2001 Sweep Generator, 1-1400 MHz, +10 dBm, 70 dB atten. $750.00
WAVETEK 2002B Sweep Generator, 1-2500 MHz, +13 dBm, GPIB $1750.00
WILTRON 6647M Sweep Generator, 10 MHz-20 GHz, +10 dBm, GPIB $4500.00
WILTRON 6669B-02,03 Sweep Gen., 0.01-26.5 GHz/ K conn.& 26-40 GHz/ WR28 ..... $7500.00
WILTRON 6717B-20 Synthesizer/ Sweeper, 10 MHz-8.4 GHz, +13 dBm,GPIB $6000.00

POWER METERS

BOONTON 42B/ 41-4E Analog Power Meter, with 1 MHz-18 GHz sensor $400.00
HP 11683A Range Calibrator, for HP 435/6/7/8 ..... $750.00
HP 435B/8481A Power Meter, -30 to +20 dBm, 10 MHz-18 GHz $900.00
HP 436A-022/ 8481A Power Meter, -30 to +20 dBm, 10 MHz-18 GHz, HPIB $1200.00
HP 436A-022/ 8482A Power Meter, -30 to +20 dBm, 100 kHz-4.2 GHz, HPIB $1200.00
HP 436A-022/ 8484A Power Meter, -70 to -20 dBm, 10 MHz-18 GHz, HPIB $1200.00
HP 436A-022/ 8485A Power Meter, -30 to +20 dBm, 50 MHz-26.5 GHz, HPIB $1500.00
HP 436A-022/ 8485D Power Meter, -70 to -20 dBm, 50 MHz-26.5 GHz, HPIB $1700.00
HP 438A Dual Channel Power Meter $3000.00
HP 8477A Power Meter Calibtator, for HP 432 series $400.00
HP 8487D High Sensitivity Sensor, -70 to -20 dBm, 50 MHz-50 GHz, 2.4mm $1850.00
HP 8900D/84811A Peak Power Meter, 0.1-18 GHz, 0-20 dBm peak $2500.00
HP Q8486A Power Sensor, 33-50 GHz, -30 to +20 dBm, for 435/6/7/8 ..... $1500.00
HP R8486A Power Sensor, 26.5-40 GHz, -30 to +20 dBm, for 435/6/7/8 ..... $1500.00

RF MILLIVOLTMETERS

BOONTON 92C RF Millivoltmeter, 3 mV-3 V f.s., 10 kHz-1.2 GHz $500.00
RACAL-DANA 9303 RF Millivoltmeter, -70 to +20 dBm, 10 kHz-2 GHz, GPIB $750.00

AMPLIFIERS, MISCELLANEOUS

AMPLIFIER RESEARCH 4W1000 Amplifier, 40 dB gain, 4 Watts, 1-1000 MHz $950.00
BOONTON 82AD Modulation Meter, AM/ FM, 10-1200 MHz $500.00
C.P.I. VZC6961K1 TWT Amplifier, 35 dB gain, 4-8 GHz, 20 Watts $3500.00
ENI 525LA Amplifier, 50 dB gain, 1-500 MHz, 25 Watts $3250.00
HP 11713A Switch / Attenuator Driver, HPIB $800.00
HP 11729B-003 Carrier Noise Test Set, 5 MHz-3.2 GHz $1900.00
HP 3730B/3738B Downconverter, 5.9-8.9 GHz & 8.7-11.7 GHz $1200.00
HP 415E SWR Meter $200.00
HP 8347A RF Amplifier, 25 dB gain, 100 kHz-3 GHz, +20 dBm, HPIB $2750.00
HP 8349A Amplifier, 15 dB gain, 2-20 GHz, +20 dBm output $1650.00
HP 8403A-002 Pulse Modulator, 0.8-2.4 GHz, 80 dB dynamic range $450.00
HP 8406A Comb Generator, 1/ 10/ 100 MHz increments, to 5GHz $500.00
HP 8447A-001 Dual Amplifier, 20 dB, 0.1-400 MHz, +6 dBm Po, NF <7 dB $650.00
HP 8447D-010 Preamplifier, 25 dB gain, 0.1-1300 MHz, <8.5 dB NF $750.00
HP 8447E Amplifier, 22 dB, 0.1-1300 MHz,+13 dBm output $650.00
HP 8447F-H64 Dual Amp., 0.01-50 MHz 28 dB & 0.1-1300 MHz 25 dB $900.00
HP 8901A Modulation Analyzer, 150 kHz-1300MHz, HPIB $1350.00
HP 8901B-001 Modulation Analyzer, 150 kHz-1300 MHz, HPIB $1900.00
MPD LAB-1-510-10 Amplifier, 48 dB gain, 500-1000 MHz, 10 Watts $750.00
RACAL 9009 Modulation Meter, 30-1500 MHz, AM, 1.5-100 kHz pk FM $350.00
RF POWER LABS ML50 Amplifier, 2-30 MHz, 47 dB gain, 50 Watts, metered, 28 V $200.00
ROHDE&SCHWARZ ESH2 Test Receiver, 9 kHz-30 MHz $3250.00

COAXIAL & WAVEGUIDE

AEROWAVE 28-3000/10 WR28 Directional Coupler, 10 dB, 26.5-40 GHz $300.00
AMERICAN NUC. AM-432 Cavity Backed Spiral Antenna, LHC, 2-18 GHz, TNC(f) *NEW* $95.00
AVANTEK AMT-400X2 WR28 Active Doubler, +10 dBm in & out $450.00
BIRD 8201 500 Watt Oil Dielectric Load, DC-2.5 GHz $350.00
FXR/MICROLAB SL-03N Stub Stretcher, 0.3-6.0 GHz, 100 Watts max., N(m/f) $75.00
GENERAL RADIO 874-LTL Constant Impedance Trombone Line, 0-44 cm, DC-2 GHz $400.00
HP 11590A-001 Bias Network, 1.0-18.0 GHz, APC7 ..... $450.00
HP 11691D Directional Coupler, 22 dB, 2-18 GHz, N connectors $450.00
HP 11692D Dual Directional Coupler, 22 dB, 2-18 GHz $800.00
HP 33327L-006 Prog. Step Attenuator, 0-70 dB, DC-40 GHz, 2.9mm $1000.00
HP 778D-011 Dual Dir. Coupler, 20 dB, 0.1-2.0 GHz, APC7 ..... $450.00
HP 8498A-030 30 dB Attenuator, 25 Watts, DC-18 GHz $500.00
HP 87300C-020 Directional Coupler, 20 dB, 1.0-26.5 GHz, 3.5mm $475.00
HP K422A WR42 Flat Broadband Detector, 18.0-26.5 GHz $350.00
HP K532A WR42 Frequency Meter, 18.0-26.5 GHz $450.00
HP K752A WR42 Directional Coupler, 3 dB, 18.0-26.5 GHz $450.00
HP K752C WR42 Directional Coupler, 10 dB, 18.0-26.5 GHz $450.00
HP K752D WR42 Directional Coupler, 20 dB, 18.0-26.5 GHz $450.00
HP K870A WR42 Slide Screw Tuner, 18.0-26.5 GHz $275.00
HP K914B WR42 Moving Load, 18.0-26.5 GHz $250.00
HP Q752D WR22 Directional Coupler, 20 dB, 33-50 GHz $650.00
HP R281A WR28 x 2.4mm(f) Adapter $600.00
HP R422A WR28 Crystal Detector, 26.5-40 GHz $400.00
HP R752A WR28 Directional Coupler, 3 dB, 26.5-40 GHz $450.00
HP R752D WR28 Directional Coupler, 20 dB, 26.5-40 GHz $450.00
HP R914B WR28 Moving Load, 26.5-40 GHz $250.00
HP V365A WR15 Isolator, 25 dB, 50-75 GHz $750.00
HP V752D WR15 Directional Coupler, 20 dB, 50-75 GHz $650.00
HP X870A WR90 Slide Screw Tuner $150.00
HUGHES 45322H-1110/1120 WR22 Directional Couplers, 10 or 20 dB, 33-50 GHz $350.00
HUGHES 45712H-1000 WR22 Frequency Meter, 33-50 GHz $750.00
HUGHES 45714H-1000 WR15 Frequency Meter, 50-75 GHz $900.00
HUGHES 45722H-1000 WR22 Direct Reading Attenuator, 0-50 dB, 33-50 GHz $1000.00
HUGHES 45724H-1000 WR15 Direct Reading Attenuator, 0-50 dB, 50-75 GHz $1000.00
HUGHES 45732H-1200 WR22 Level Set Attenuator, 0-25 dB, 33-50 GHz $250.00
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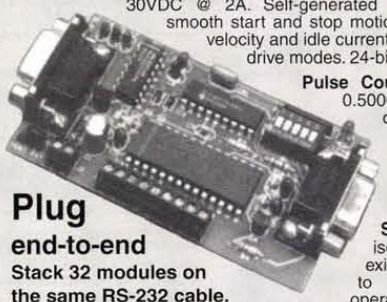

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Build The Telephone Call Logger

By Peter Crowcroft

Keep track of all outgoing calls, whether they're long distance or local, for business or home ...

Have you ever opened your phone bill and thought "I can't have made so many calls." Most phone bills itemize long distance calls and give details of the number dialed. But local calls are just totalled up — you have no way of knowing who those calls were made to.

What about small businesses that operate from home? They can usually claim a percentage of phone calls for income tax purposes. With the Call Logger, ALL calls are recorded and it is simply a matter of sorting them to determine how many were business calls. And it all happens automatically. Only DTMF tone dialing is supported.

The logger records the start and stop time of ALL outgoing calls along with the number dialed (plus any other digits pressed during the call). It operates "stand alone" — no need for any connection to a PC.

Telephone call data is output in a format that can be easily imported into Microsoft Excel. Various Excel functions can then be used to analyze and sort the data and produce formatted printouts.

Data is stored in non-volatile EEPROM memory, so there is no loss of data in the event of a power failure. The kit is supplied with 16K of memory and is expandable in 16K blocks up to 64K total. The kit "auto detects" the amount of available memory — just plug it in and go.

The number of calls that can be recorded depends on the amount of memory installed and the number dialed. Each call requires the following minimum number of bytes:

- Start date and time — six bytes
- Stop data and time — six bytes
- Record terminator — one byte

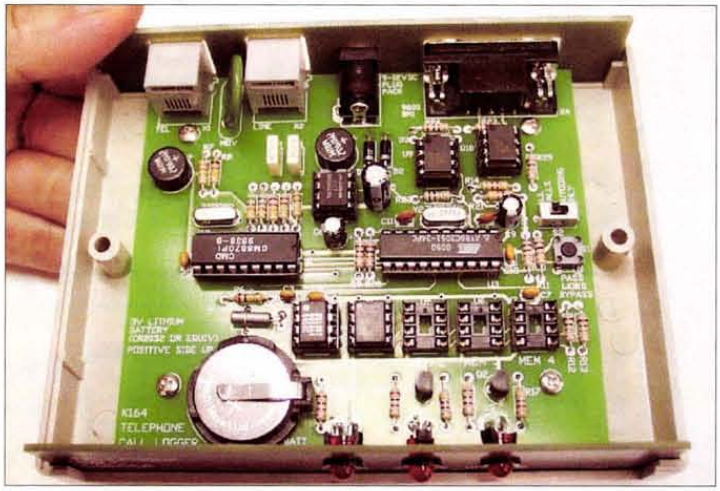
Each digit dialed requires one byte. So, each call occupies 13 bytes of memory PLUS one byte for each digit dialed. Allowing for 11 bytes of system overhead (password storage), this leaves 711 x 10-digit phone numbers that can be stored in the basic kit with 16K of memory installed [(16384-11)/23 bytes.] With the full 64K memory installed, this is 2848 x 10-digit phone numbers. Ten digits is just taken as an example. If you are in a country where only seven or eight digits are used per call, then you will get more calls stored. If you pay your bills by credit card, then about 50 to 55 bytes will be used per call.

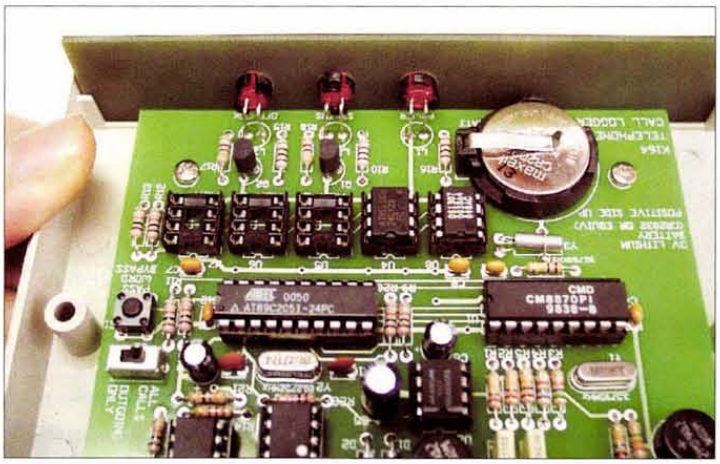
Access to all logger functions, including downloading of call data, is password protected.

Three LEDs are provided on the front panel to indicate power on, offhook (call in progress), and memory status. The memory status LED flashes when the memory is 75% full and is permanently on when 100% full.

As a bonus, call data is also output in "real time" to the serial port, as well as being recorded in memory. This is useful when immediate call analysis and/or external data logging is required. This "real time" output is unaffected by the memory status — even if the memory is full, the call data is still output. You can attach this serial output to the parallel port of a printer by going through a serial-to-parallel converter. These interface boards are readily available commercially.

Two RJ12 (USA-type) telephone sockets are available on the rear panel, marked "LINE" and "PHONE." The telephone line connects to the "LINE" connector and an optional telephone can be connected to the "PHONE" connector. This allows a telephone to be connected and used even when the logger is put in its place. Telephone line cords are not supplied with the logger.





The kit is constructed on a double-sided, through-hole plated printed circuit board (PCB) and fits in a plastic case measuring 130(W) x 100(D) x 30(H)mm. Screen-printed front and rear panels are supplied.

The kit requires a 9-to-12V DC power supply. A 12VDC wall adaptor rated at 300mA is suitable.

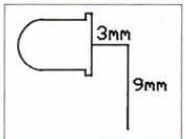


Figure 1

ASSEMBLY INSTRUCTIONS

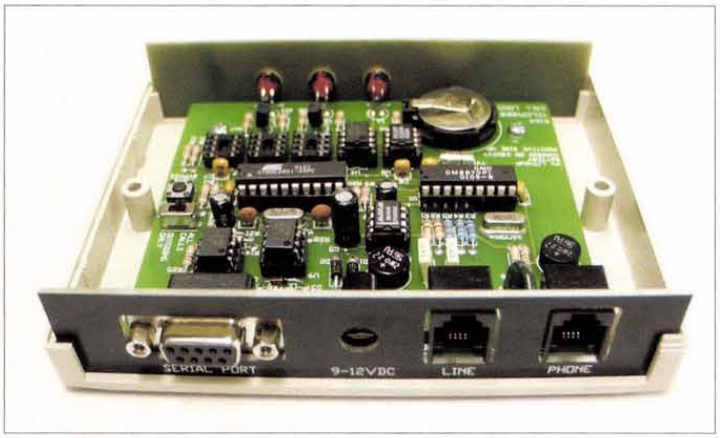
Use the component overlay on the PCB to place the components in the following order. Leave the LEDs until final assembly.

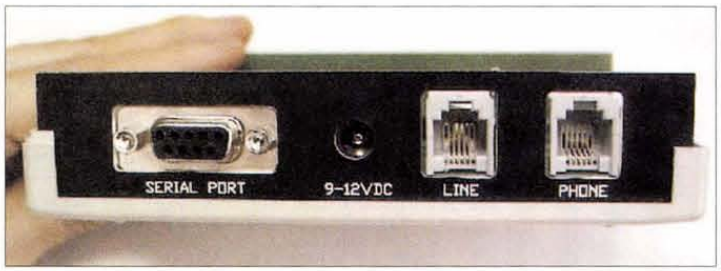
1. Resistors and diodes. Put in the four 1% metal film resistors around the DTMF decoder first; R3-6.

2. IC sockets.

3. Crystals and capacitors. Use a resistor lead offcut to hold down crystal Y3 against the PCB.

4. Transistors and the two switches.





5. Battery holder and diode bridges.
6. DC jack and D9 connector.
7. Both telephone connectors.
8. Metal Oxide Varistor (MOV). Push this as far down onto the PCB as possible. It is tall and will need to be pushed right in so the lid will fit.

Do not insert any ICs yet.

The plastic box is in two halves. Take the bottom half and fit the rear panel into the slot provided. Now drop in the PCB and slide it back so that the telephone and D9 connectors protrude through the panel. Fix the PCB into place using the four self-tapping screws provided.

Now comes assembly of the front panel. Start by inserting the three LED clips into the holes, pushing them in from the front. Now insert the LEDS into the clips from the rear. The LEDs should "click" into place.

Turn the LEDs in the clips so that the long lead is to the left when viewed from the front. This means that the flat edge of the LED (short lead, cathode) will be to the right when viewed from the front and will correspond to the flat marked on the overlay. This is very important so make sure it is right. Now bend the leads down at right angles, about 3mm from the LED body, as shown in Figure 1. Use a pair of long nose pliers to hold the leads while bending. Cut the leads off to a length of about 9mm from the bend.

Position the front panel onto the case and drop it into place, making sure that the LED leads are inserted into their matching holes on the PCB. Once the panel is in place, solder the LED leads from the top of the PCB.

Insert the 5V regulator IC, U2 (MAX666), into its socket. Connect a power supply to the DC jack. The power LED on the front panel should light. Measure the DC voltage output of the regulator. The easiest place to do this is to measure across pins 10 (GND) and 20 (+5) of the U3 IC socket. It should read five volts.

If okay, disconnect the power and insert the rest of the ICs. Take care that the ICs are the correct way around and none of the leads are bent under the body of the IC.

The EEPROM (24C128) must be inserted in position, 'MEM 1' (U4). Any extra EEPROMs must be inserted in order from left to right starting at 'MEM 2' (U5). The DS1307 clock/calendar chip, U8, is located to the left of all the EEPROMs. The lithium battery is inserted in the battery holder with the positive side up. Note we have not supplied a battery because fresh CR2032 batteries are readily available everywhere. (We do not want to supply kits with flat batteries.)

Do not fit the plastic case lid just yet. Proceed to the section "INSTALLATION AND SETUP." Now fit the plastic case lid and secure it in place.

CIRCUIT DESCRIPTION

The kit is controlled by U3, a preprogrammed 89C2051 microcontroller from Atmel. This was chosen because it has the required number of I/O pins and a built-in serial port. It has 2K bytes of flash memory which is pre-programmed with the control firmware.

U2, a Maxim MAX666, provides two functions:

1. Five-volt regulator (via pin 2) to power the rest of the circuitry. The diode bridge B1 provides polarity protection. The MAX666 maximum input voltage is 16.5 volts. Some 12V (nominal) plug packs actually output a lot higher voltage at low output currents, up to 17V in some cases. Diodes D1 and D2, along with B1, allow voltages up to 18.9V to be used to power the kit.

2. Low Battery Detect, intended for use with battery powered equipment. In this application, it is used to detect when the telephone line is 'looped' (in use). The DC voltage of a telephone line is nominally 48 volts. This drops to around 12 volts or less when looped. The chip detects this voltage drop and pulls pin 7 low. Diode bridge B2 provides

Figure 2

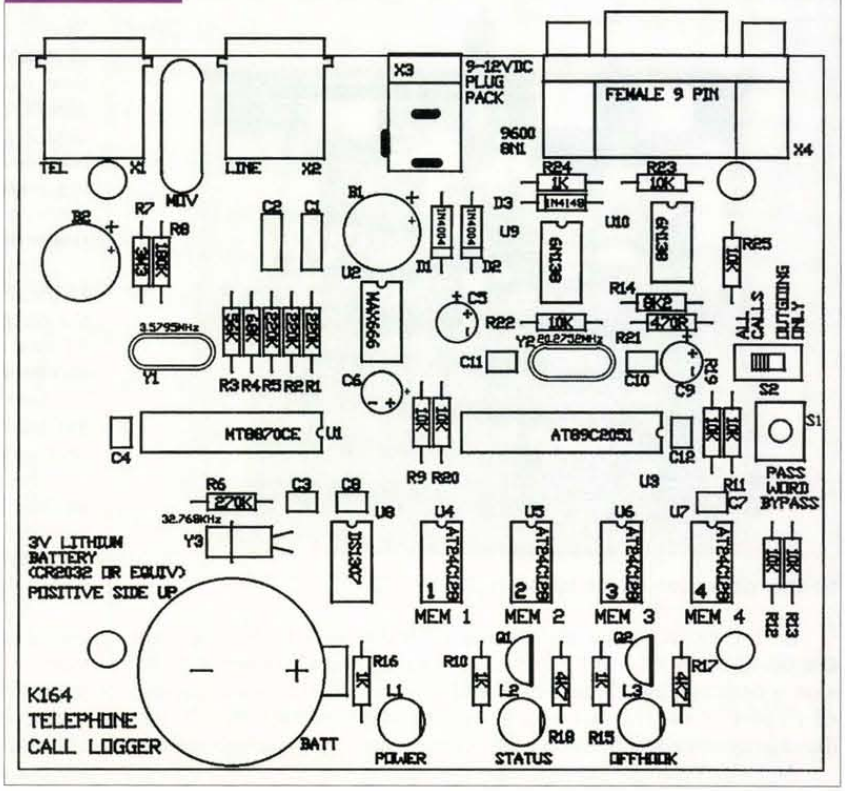
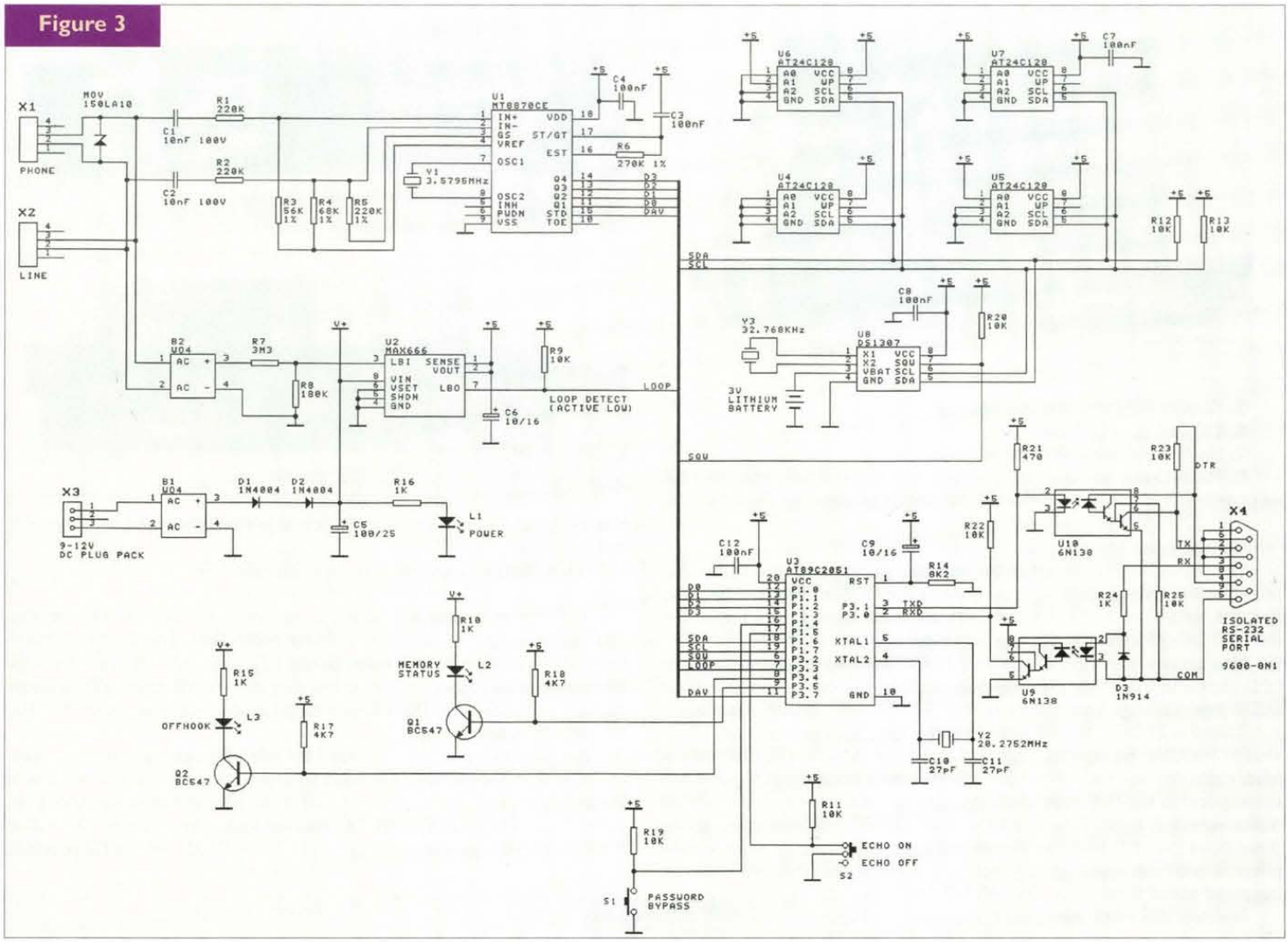
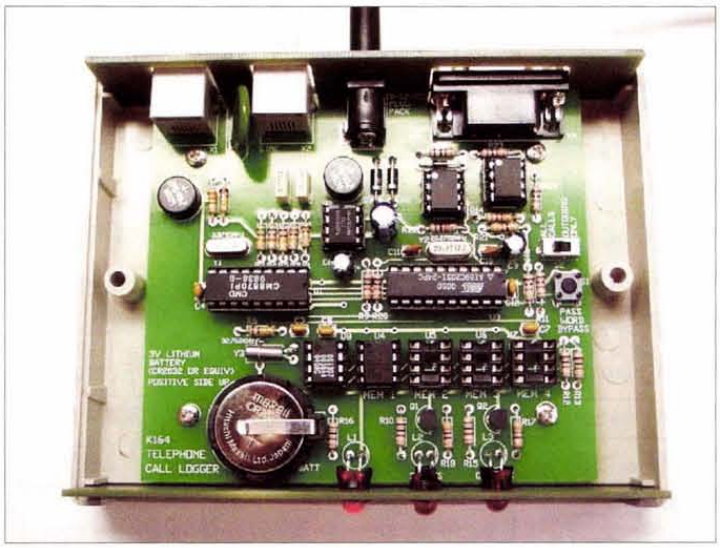


Figure 3





polarity protection on the telephone line.

U1 (MT8870CE) is a DTMF decoder. It connects to the telephone line via resistors R1 and R2 and capacitors C1 and C2. When a DTMF tone is detected, pin 15 goes high and the four-bit digit data is presented on pins 11-14. The metal oxide varistor (MOV) protects the kit from damage by any short duration high-voltage spikes on the telephone line.

All clock/calendar functions are provided by U8 (DS1307), a Serial Real Time Clock from Dallas Semiconductor. It uses a two-wire I2C serial interface to communicate with the microcontroller. It features real-time clock counts for seconds, minutes, hours, date of the month, month, day of the week, and year with leap year compensation valid until 2100. It has a squarewave output (pin 7), programmed to give a one-second signal. This is used by the microcontroller firmware to flash the memory status LED. The chip also features automatic power-fail detect and switch circuitry. The 3V lithium battery provides back-up power during a power failure.

Non-volatile memory storage is provided by up to four AT24C128 EEPROMs, U4 to U7. These also use a two-wire I2C serial interface like the clock chip. The EEPROMs are 128K bit types organized as 16K x 8. At least one EEPROM (U4) must be present. The rest are optional and can be inserted in sequence by the user, as required.

Two switches are provided. S1 is a push-button type and is used for 'password bypass.' S2 is a slide switch and is used to set the type of calls recorded. More on these later.

The serial interface is a bit unusual. It is not the regular type offering RS232-type signal levels. Instead we have used two high-speed opto-isolators, U9 and U10. These were necessary to provide complete electrical isolation between any PC connected to the serial port and the telephone line.

An RS232 interface uses a common 'ground' signal between each end of the interface. At the PC end, this 'ground' signal is connected to mains earth. This mains earth would then be connected to the telephone line via on-board circuitry in the data logger. Since both sides of a telephone line are normally 'floating' above earth, earthing one side of the line would cause a fault condition at the telephone exchange and the line would stop working properly.

The solution is to use an opto-isolated serial port for connection to a PC. Otherwise, the kit would have to be disconnected from the phone line BEFORE connecting a PC to it. It would also mean that a PC could not be permanently connected to capture the 'real time' output from the logger.

The receive side of the serial interface (U9) is simple. The RS232 voltage levels from the PC drive the LED in U9 via R24. Diode D3 protects the LED from reverse currents when the RS232 level goes negative.

The transmit side of the serial interface (U10) requires a positive voltage to bias the output transistor. To maintain electrical isolation, this voltage is provided by the PC side of the interface via the DTR line. The 'active' state of DTR is +12V (nominal). R23 is the collector load resistor for U10's open-collector output, while R25 provides bias for the Darlington output stage, reducing the turn-off time of the output.

What about the power supply you say? Yes, it also must be isolated from mains earth. This is not really a problem when using a plug pack. Plug packs normally use a two-pin connection to mains (no earth pin). They also use a transformer to convert the mains voltage, which provides further electrical isolation from earth.

SERIAL PORT PARAMETERS

Any communications program used to 'talk' to the logger must configure its serial port to:

9600 baud, eight data bits, one stop bit, no parity bit

No 'handshaking' or 'flow control' is used. The logger does require that the DTR line is 'active,' i.e., +12V. This is the default for most comms programs, anyway.

INSTALLATION AND SET-UP

The logger needs to be 'set up' before use. You will need a PC running a communications program. Any comms program will do. Windows users can use HyperTerminal, which comes with Windows itself. We use our own term.exe. You may download this from http://kitsrus.com/zip/term.zip.

The zip file includes a detailed explanation of how to set up and use term.exe under W98.

- Connect a PC to the logger via one of the serial ports. Use a nine-way, male-to-female 'straight-though' cable.
- Start the comms program and set the serial port parameters as described above. Make sure the correct serial port is selected.
- Power up the logger. A banner is printed showing the firmware version number and the amount of EEPROM memory installed.
- Hold the "PWD BYPASS" switch (S1) down and press the 'Enter' or 'Return' key on the PC keyboard.
- A menu will be displayed, as follows:

1. Download data
2. Clear data
3. Set date
4. Set time
5. Change password
0. Exit

- Set the date — option 3. The current date will be displayed and you will be prompted to enter the new data. The date is entered as "mm/dd/yy" (including the '/').

Note: The logger does not check for valid dates, e.g., if you enter "15/66/01," it will accept it.

- Set the time — option 4. The current time will be displayed and you will be prompted to enter the new time. The time is entered in 24-hour format as "hh:mm:ss" (including the ':').

Note: As with the date, the logger does not check for valid times, e.g., if you enter "29:77:99" it will accept it.

- Set the password — option 5. You can use any letter, number, or punctuation mark, but it must be at least four characters long, up to a maximum of eight characters.

Note: Lower and upper case letters are treated as different characters, e.g., the lower case letter 'a' is not the same as capital 'A.'

- The last thing is option 2 — Clear data. This MUST be done so that the memory is initialized correctly.
- Now exit the menu using option 0. A "READY" prompt is displayed.

Select the type of calls to log, as described next.

TYPES OF CALLS

The logger has an on-board switch (S2) that is used to select the type of calls to record.

A call is defined as any time the phone line is looped (that is, the handset is picked up and the OFFHOOK LED is on).

Types of calls are defined as follows:

1. Outgoing Calls Only

SOURCES

Amazon Electronics, Inc.
14172 Eureka Rd., P.O. Box 21
Columbiana, OH 44408-0021
Tel **(330) 549-3726**, Toll Free **1-888-549-3749**,
Fax **(603) 994-4964** or **(330) 549-3725**
amazon@electronics123.com
www.electronics123.com
Part Number: K164

Carl's Electronics, Inc.
P.O. Box 182, Sterling, MA 01564
(978) 422-5142 phone
(978) 422-8574 fax
www.electronickits.com
sales@electronickits.com
Part Number: CK602
(www.electronickits.com/kit/complete/tele/ck602.htm)

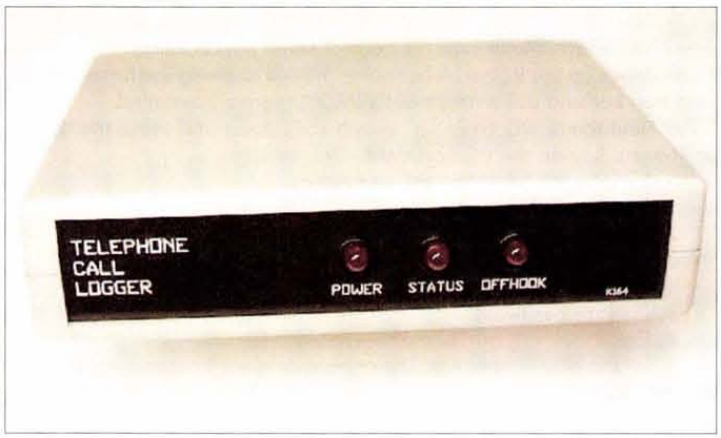
Circuit Specialists, Inc.
220 S. Country Club Dr., Mesa, AZ 85210
1-800-528-1417, **480-464-2485**, Fax: **480-464-5824**
www.web-tronics.com
Part Number: 164

Marlin P. Jones & Assoc., Inc. (MPJA)
P.O. Box 530400, Lake Park, FL 33403
(800) 653-6733
www.mpja.com
mpja@mpja.com
Part Number: 8464 KT

Ozitronics
Melbourne, Australia
+613 9434 3806
sales@ozitronics.com
www.ozitronics.com
Part Number: K164

Quality Kits
49 McMichael St.
Kingston, ON, K7M 1M8, Canada
1-888-GO-4-KITS
Part Number: K164

TSSD Enterprises
8345 N.W. 66th St., #3309, Miami, FL 33166-2626
305-418-7510, Fax: **305-437-7628**
ms_enterprises2002@hotmail.com



These are calls where the handset is picked up and at least one digit is dialed. If no digits are dialed, no data is recorded.

2. All Calls

Data is recorded any time the line is looped, regardless of whether any digits are dialed or not. If no digits are dialed, then it was probably an incoming call.

The logger does not have 'caller ID' circuitry and is not able to record the phone number of incoming calls.

TESTING

Use a telephone line cord to connect the logger to the telephone line via the 'LINE' connector on the back of the logger and connect a suitable power supply (12VDC plug pack).

Once connected to the phone line, we can test that it is actually recording calls. Connect a PC to the logger and run the comms program. This will enable us to see the 'real time' output.

Now pick up the phone. The 'OFFHOOK' indicator should light and the current date and time printed on the PC screen. Dial a few digits — they should be displayed as they are pressed. Now hang up. The 'OFFHOOK' indicator should go off and the date and time printed on the screen.

Now we will check if it was recorded into memory. Press the 'Enter' or 'Return' key on the PC keyboard. You will be prompted for a password. Enter your password. You only have five seconds to start and between each character. If the password is correct, a menu is displayed. Choose option 1 — Download data. The call you just made should be displayed there.

Notice that the recorded format is slightly different to the 'real time' output. In the 'real time' output, everything is printed as it happens, i.e., the START date/time followed by the digits dialed followed by the END date/time. The recorded format has the START date/time followed by the END date/time followed by the digits dialed. This makes the data easier to read if simply making a printed copy.

OPERATION AND USE

The logger does not need a PC connected to log calls. A PC is only required to set or check the onboard clock and download any recorded call data.

If the data memory becomes full, the logger will not log any more calls. In this case, connect a PC and download the data (see SAVING CALL DATA TO A DISK FILE). Once saved, the memory MUST be cleared for the logger to continue logging further calls.

NOTE: The logger will not log any calls while the menu is displayed. You must exit the menu (enter '0') to resume normal operation.

CONTACT US

You may contact the **term.exe** writer at **frank@ozitronics.com**. If you have suggestions on how to improve this documentation, email me at **peter@kitsrus.com**.

WHAT IF I FORGET MY PASSWORD?

In this case, you will need to remove the lid from the logger and hold down the 'PWD BYPASS' switch before you press 'Enter' or 'Return.'

ADDING MORE MEMORY

The logger uses up to four AT24C128 EEPROMs for data storage. Each EEPROM is 16K bytes giving a total of 64K of memory. Only one EEPROM (16K) is supplied as standard with the kit.

The memory is user upgradeable by simply 'plugging in' more EEPROM's. Disconnect the power and telephone line and remove the lid. Insert the EEPROM(s) according to the following table.

Memory	Position
16K	MEM 1
32K	MEM 1, 2
48K	MEM 1, 2, 3
64K	MEM 1, 2, 3, 4

WHAT DO THE LIGHTS MEAN?

POWER indicates that power is connected to the logger.

OFFHOOK indicates that the phone line is looped (in use). It will only indicate if the line was looped AFTER the logger was connected. If the line is already in use when the logger is connected, then the indicator will remain off until the NEXT time the line is used.

The STATUS indicator has a number of meanings. It is used to indicate the amount of memory left for logging calls. When the memory capacity reaches 75% full, the STATUS light starts flashing. When the memory is completely full, the light is permanently ON and no more calls will be logged.

The STATUS light is also permanently ON to indicate possible battery failure on the clock. If the battery has failed, then the clock data may be corrupted or incorrect. In this case, you will need to use the logger's menu to check the date and time. Test the battery and replace if necessary.

If both the STATUS and OFFHOOK lights are ON when the logger is powered up, it means that the logger could not detect any EEPROM memory at all. If you connect a PC to the logger and run a comms program, you will see the words "MEMORY ERROR" continuously printed. Check that there is an EEPROM in position 'MEM 1' or re-seat the chip if one is present.

DOWNLOAD DATA FORMAT

The recorded call data is printed out in the following format:

```
|—Start date and time—| |—End date and time—|
|-digits dialed-|
dd-mon-year hours:mins:secs,dd-mon-year
hours:mins:secs,all numbers pressed
```

The date is in the form "12-May-01" and the time is in 24-hour format as in "13:30:00" (1:30 pm). Each data record (call) is terminated by a "carriage return/line feed" combination.

SAVING CALL DATA TO A DISK FILE

Now all the call logged data is sitting in MEM1 (and MEM2, 3, and 4, if present.) We want to get this data from these IC(s) into our PC. How do we do this?

Answer: We download the data using a 'comms' (communications), program running on a PC that 'captures' the data to a disk file as it is displayed on the screen. All comms programs have a 'data capture' or 'logging' function where everything displayed on the screen is also saved to a disk file. The file is a simple ASCII text file. W9x has its own comms program — Hyperterminal — built in and you can use this. But we use term.exe which is our own program and which can be downloaded from our website. (Remember, you can download this from

http://kitsrus.com/zip/term.zip. The file includes a detailed explanation of how to set up and use term.exe under W98.)

The following description assumes you are running term.exe. (Similar event sequences apply to all comms programs.)

Connect to the logger with your PC and start term running by clicking on the term.exe icon. After the screen has appeared, press 'Enter.' You will be prompted for a password. Enter the password and a menu will be displayed. (The phone must not be in use — offhook LED lit — when you do this.) If you do not enter your password within five seconds, the software will return to ready mode and will log data. Hit Enter to get the password prompt back.

After successful password entry, you will get the Menu. Now turn on 'data capture' by pressing alt-L. You should be prompted for a file name to save to (term.log is the default). Hit Enter. LOG will appear on the bottom line of the display to show logging is on. Then choose option 1 — Download data. Hit Enter. All recorded data will be printed out (in the format described previously). When finished, turn off 'data capture' by pressing alt-L again. Note that LOG disappears from the bottom line. All the data has now been saved to the disk file 'term.log.' Finally, press '0,' press Enter — the logger will exit the menu and return to normal operation. To exit term.exe, hit alt-Q. Note logging must be turned off to allow you to exit from term.exe.

Note that you cannot stop the scrolling of the data after you press '1.' The whole data in MEM1..4 is dumped to term.log in one go. You have to go to term.log with a text editor to look at the individual data lines or load it into Excel as described next.

IMPORTING DATA INTO MICROSOFT EXCEL

The data in term.log is in a format that can be easily imported into Microsoft Excel. First, edit term.log to remove unwanted data from the start and end of the file. Once done, the data can now be imported into Excel. The following step-by-step guide will show you how to import the file into Microsoft Excel. It has been tested using Excel 97 and 2000.

1. Click on "File ® Open."
2. In the 'Files of type' box, select 'All Files (*.*).'
3. Browse to the saved data file, select it, and click 'Open.'
4. A 'Text Import Wizard' dialog box will appear. Under 'Original data type' select 'Delimited.' Click 'Next.'
5. A second dialog box will appear. Here you can choose which delimiters to use to break up the file into columns. If you want the data and time to be one column, then select 'Comma' only. If you want the date and time to be separate columns (recommended) then select both 'Comma' and 'Space' as delimiters. A preview will show you how choosing each delimiter affects the file. Click 'Next.'
6. A third and last dialog box appears. Here you can choose how Excel interprets each column of data. Select each column in turn and set the 'Column data format' to 'Text.' Click 'Finish' when done.

CALCULATING CALL DURATION

Once you have imported the data, we can use Excel's date and time functions to calculate the length of each call. We can then sort the file into order starting with the longest duration call first.

The data should have been imported in five columns labeled as follows:

Column	Data
A	Start date
B	Start time
C	End date
D	End time
E	Digits dialed

The data should start in row 1. We will now create a column of data that is the duration of each call.

1. Click on cell 'F1.'
2. Type in the following formula:

=DATEVALUE(C1) + TIMEVALUE(D1) - DATEVALUE(A1) - TIMEVALUE(B1)

This tells Excel to subtract the start date (A1) and time (B1) from the end date (C1) and time (D1).

3. Click on cell 'F1' again.
4. From the menu select "Format ® Cells."
5. The "Format Cells" dialog box will appear. In the 'Number' tab under 'Category' list, select 'Time.' Under 'Type,' select '37:30:55.' The call duration is now shown in "hours:minutes:seconds" and can span multiple days.

We now want to copy this formula and formatting to the rest of the cells in this column down to the last data entry.

6. Click on cell F1 again. This cell contains the formula and formatting information we need.
7. Drag the fill handle over the cells to be filled.

The fill handle is the small black square in the corner of the selected cell (F1). When you point to the fill handle, the mouse pointer changes to a black cross.

The cells should now contain the duration of each call.

Note: Some calls may span across midnight from one day to the

PARTS LIST — KIT 164

Resistors (0.25W carbon film unless specified)		
470	R21	1
1K	R10 15 16 24	4
4K7	R17,18	2
8K2	R14	1
10K	R9 11 12 13 19 20 22 23 25	9
56K	R3 1% metal film	1
68K	R4 1% metal film	1
180K	R8	1
220K	R1,2	2
220K	R5 1% metal film	1
270K	R6 1% metal film	1
3M3	R7	1
Capacitors		
27pF ceramic	C10,11	2
10nF 100V monobloc	C1,2	2
100nF monobloc	C3,4,7,8,12	5
10uF 16V electrolytic	C6,9	2
100uF 25V electrolytic	C5	1
Semiconductors		
1N4004 diode	D1,2	2
1N4148	D3	1
WO2 bridge rectifier	B1,2	2
BC547	Q1,2	2
LED, 5mm Red	L1,2,3	3
MT8870CE DTMF receiver	U1	1
MAX666, 5V regulator	U2	1
AT89C2051-24PC Pre-programmed with K164 firmware	U3	1
AT24C128 Serial EEPROM (Note: Only 1 supplied with kit)	U4,5,6,7	4
DS1307 Serial Time Clock	U8	1
6N138 or 139 optocoupler	U9,10	2
Miscellaneous		
Crystal, 3.579MHz	Y1 49US	1
Crystal, 20.2752MHz	Y2 49US	1
Crystal, 32.768KHz	Y3 tuning fork type	1
Metal Oxide Varistor	MOV	1
Phone connector, 6 way 4 pin	X1,2	2
DC Jack, 2.5mm	X3	1
D9 connector PCB mounting, female	X4	1
Push-button switch	S1	1
SPDT Slide switch	S2	1
Lithium battery, 3V CR2032 or equivalent	BATT ...	not supplied
Battery holder		1
IC socket, 8 pin, for	U2,4,5,6,7,8,9,10	8
IC socket, 18 pin, for	U1	1
IC socket, 20 pin, for	U3	1
LED clips, 5mm Black for	L1,2,3	3
Self-tapping screws for fixing PCB to case		4
Plastic case, 130(W) x 100(D) x 30(H)mm		1
PCB, K164		1
Set of front and rear panels		1

next. In this case, the end time will be earlier than the start time. Using the Excel DATEVALUE and TIMEVALUE functions allows the correct time duration to be calculated.

SORTING THE DATA

The data can be sorted in any order using any column as required. The following example sorts the data according to call duration (as calculated previously).

1. Click on any data cell.
2. From the menu select "Data ® Sort."
3. The 'Sort' dialog box will appear. In the 'Sort by' box, select Column F (the call duration column) and 'Descending.'
4. Click 'OK.'

The call data is now sorted by call duration with the longest call first.

Of course, you can sort the data in any order you like. Using the 'digits dialed' column will sort the data by phone numbers dialed, with all similar numbers grouped together. Sorting by "start time" will group all numbers dialed at a certain time of day.

IF IT DOES NOT WORK

Poor soldering ("dry joints") is the most common reason for the circuit not working. Check all soldered joints carefully under a good light. Re-solder any that look suspicious.

- Are all the components in their correct position on the PCB?
- Are the electrolytic capacitors the right way around? What about the diodes and diode bridges?
- Are the ICs the right way around?
- Are any IC leads bent up under the IC body?
- Is the regulator output = 5V?
- Is it connected to the telephone line?
- Is it connected to the right serial port on your PC?
- Are you using a straight-through serial cable?
- Is the correct serial port selected in your comms program?
- Is the serial port configured correctly? Is DTR active (+12V)?
- Is an EEPROM inserted in position "MEM 1" (U4)?

WEB ADDRESS AND EMAIL

You can email us at peter@kitsrus.com if you have any problems or requests. Information on other kits in the range is available from our Web page at http://kitsrus.com. For any technical problems or questions, contact the kit developer at frank@ozitronics.com.

Some kits (K121, 122, 123, 164) require a communications program to transfer data between the serial port on the PC and the kit. In Windows 9x, there is a comms program called 'Hyperterminal' already built-in. Windows 3.1x comes with the 'Terminal' comms program built in. There are many comms program you can download from software sites.

Frank Crivelli (www.ozitronics.com) has written his own DOS-based comms program called 'term.exe.' It is a simple, basic terminal program which does its job without a lot of 'bells and whistles.' (Also as of this moment, he does not know how to write Windows software!) You may download it from http://kitsrus.com/zip/term.zip.

HOW TO INSTALL 'TERM.EXE'

This is a detailed explanation of how I have installed 'term.exe' in my Windows 98 system. There are slight differences with Windows 95 and 2000, but it gives you an idea of how to do it.

1. Unzip 'term.zip.' You will get this file and 'term.exe.'

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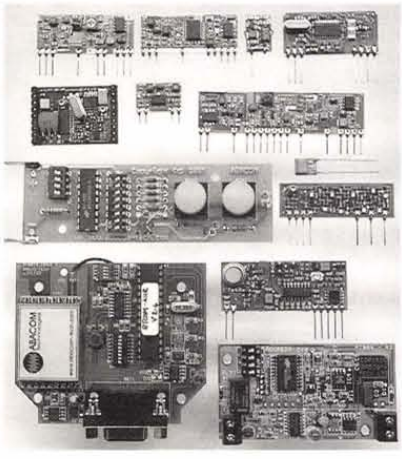

Typical Applications

- RF remote control
- Data communications
- Wireless Audio
- RF data acquisition
- Wireless Security
- Robotics
- Remote Sensing
- Remote Monitoring
- Wireless Networking

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MOUSER ELECTRONICS

Circle #70 on the Reader Service Card.

2. Move 'term.exe' to the same folder as Hyperterminal.
C:\Program Files\Accessories\Hyperterminal
(I did this because sometimes I use Hyperterminal and all my hex files for programming firmware are in the same folder.)

3. Right click on some blank space on the desktop and select "New ® Shortcut."

4. Click on the "Browse" button and find 'term.exe' on your hard disk in the above mentioned folder.

5. Click on it and select "open." Click "Next," then "Finish."

You should now have an icon on your desktop. If you want to change the icon's name, then right click on it and select "Rename."

6. Right click on this icon and select "Properties."

7. Click on the "Program" tab.

8. Go to the end of the "Cmd line" box and type in " 9600" (you must include the leading space). If you are using COM2, then type " /2 9600" instead. Notice that the "Working" directory/folder is set the same as the "Cmd line." You can change this, if necessary.

9. Click the "Close on exit" box. This will shutdown the DOS window when you quit 'term.exe.'

10. Click on the "Change Icon..." button if you want to change the icon associated with this shortcut.

11. Click on the "Screen" tab and select "Full-screen."

12. Click "OK."

To run 'term.exe,' simply click on the desktop icon.
Now see if you can communicate with the kit.

COMMUNICATING WITH THE KIT

Each of our kits has a Menu in the kit firmware. Power the kit, attach a straight-through serial cable, then click on the term.exe icon. Or start term.exe, connect power, and the serial cable. The order does not really matter. Now usually pushing the tact switch or — in the case of Kit 164 — hitting Enter will bring up the Menu. But sometimes not. Do Alt-Q to exit the program, then click on the term.exe icon again to start it again. Almost always this restart will bring up the Menu after pressing the tact switch or hitting Enter. If not, do the restart again. You should not need more than two restarts.

Note F1 brings up the Help features. In particular, Alt-D goes to a DOS shell so you can do a dir *.* or dir *.hex to see what files are in the folder. Type 'exit' to get out of the DOS shell. Alt-L starts the logging to a file feature (needed for Kit 164). When logging is on, note 'LOG' appears on the bottom line.

PROGRAMMING WITH KITS 121, 122, 123

I suggest you put the hex file you want to program into the same folder as term.exe. Then when you do an 'Alt-D' followed by a 'dir *.hex,' all the hex files will be in the same folder. You will not have to change folders using DOS commands (which an increasing number of people today do not know). Exit the folder by typing 'exit' and hitting Enter.

Put in the chip to be programmed. The Blank (B) and Erase (C or E — read the menu) commands are obvious.

To send the hex file to the programmer, hit P for program. You will be prompted 'Send file now ...' Now hit Alt-S which is (press F1) 'Send text file. Enter the hex file name. You will be prompted for the hex file name. Type it in, then press Enter. The file will now be sent to the chip to be programmed on the programmer. You can do a Verify; you will again be prompted to 'Send File Now ...'. Just hit Alt-S. The correct file name is remembered. Hit Enter and the file will be sent to be verified.

Finally, do the required Lock bit command.

In the latest Kit 123 firmware, there is a Q Bulk Programming feature built in which does CPL. You still have to do the Alt-S to send the file to the Programmer. **NV**

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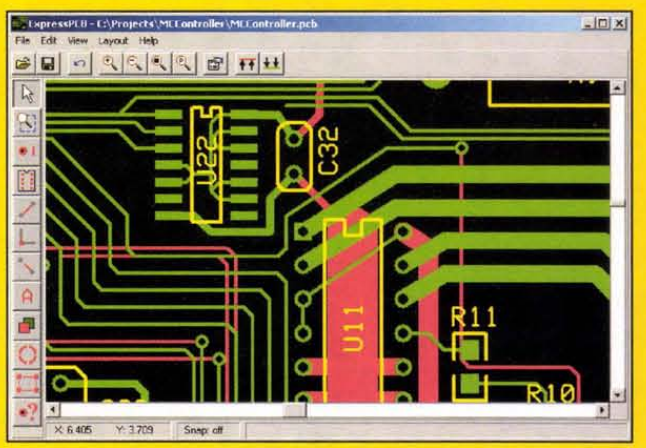

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Shortwave radio kits from Ramsey and Ten-Tec ...

by Louis E. Frenzel

Open Communication

I haven't built a kit in years. For some reason, I recently got the urge. Maybe I got addicted to rosin smoke during all those years I worked for Heathkit in their twilight days. I built dozens of their kits both large and small. I miss that.

About the same time that I was lusting for a kit, I had also been toying with the idea of getting a new short-wave receiver. With all the action going on over in Afghanistan and that part of the world, I wondered if I could pick up any interesting transmissions. We don't use short-wave much in this country, but it is still a key communications technology in the Middle and Far East and many other parts of the world. I have had my eye on the new Grundig Satellite 800 and Sangen ATS909 receivers, but both cost far more than I wanted to pay. In any case, it finally dawned on me that one way to fulfill both my wishes was to build a short-wave radio kit. So I started shopping around.

I found two interesting kit receivers, the MFJ-8100K World Band Radio made by MFJ Enterprises and the Model 1253 Ten-Tec 9-Band Short-wave Receiver. Both sell for about $70.00 and seem to be similar in design and coverage. After some deliberation, I decided to get something simpler and cheaper just to get my soldering skills back up to speed first. So I acquired two smaller kits, the Ramsey SR2 and the Ten-Tec 1054. Here is my report on these simple, inexpensive, and amazingly good receivers.

Ramsey SR2

This kit went together fast and easy. It took me about three hours all total in about three sessions. As for the soldering, it's like riding a bicycle in that you never really forget how. My skill came back quickly. The assembly was pretty straightforward except for some mods that had to be installed on the back side of the PC board. But that wasn't so bad.

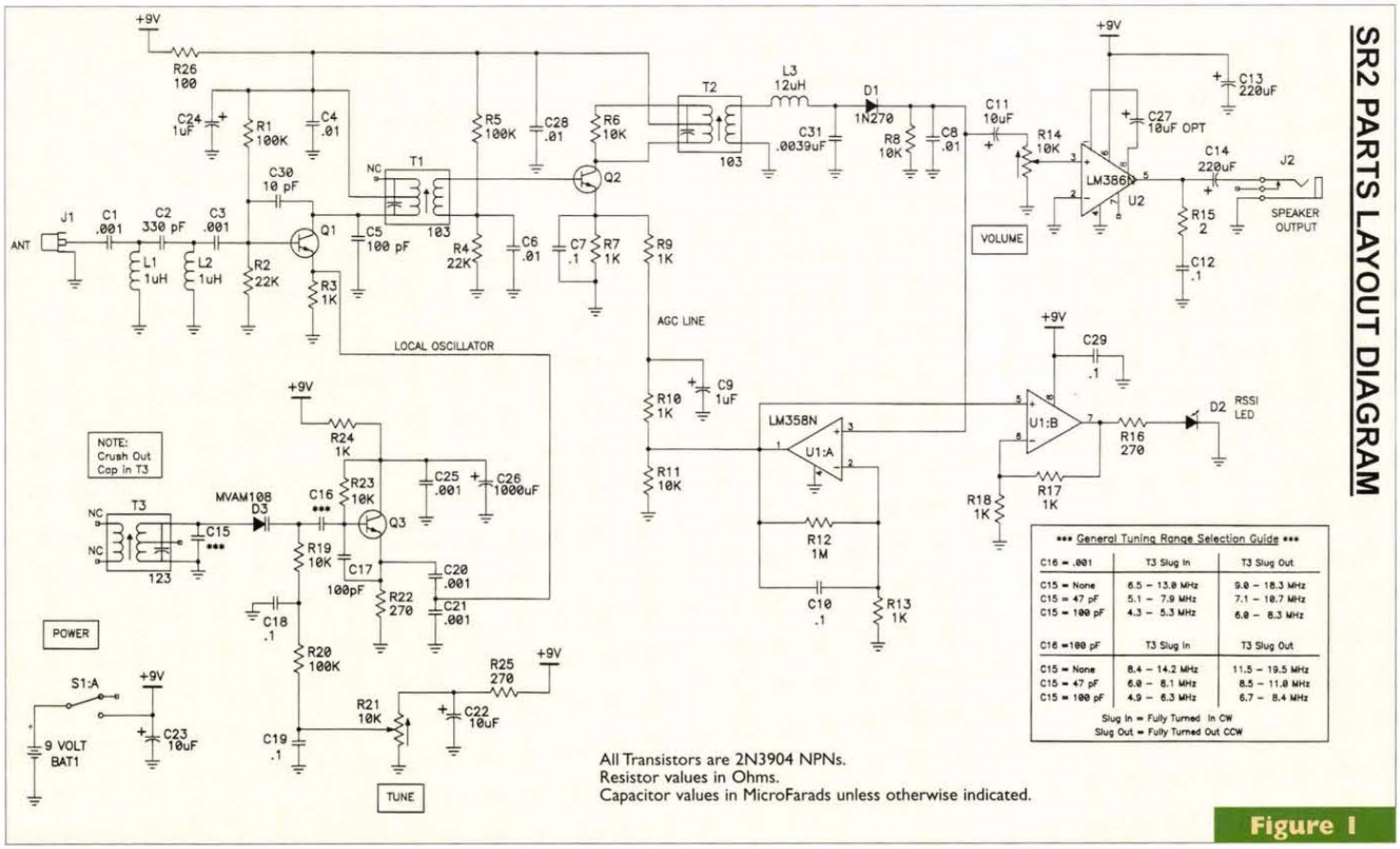
This receiver is a traditional superhet as you can see in Figure 1. The high pass filter at the front-end (C1-C2-C3-L1-L2) keeps the strong local AM stations out. A 2N3904 mixer Q1 combines the input signal with the signal from Q3, the 2N3904 Colpitts local oscillator. Tuning is accomplished with a pot that varies the DC bias on varactor diode D3. The mixer output feeds a 455 kHz IF stage using another 2N3904 Q2. The demodulator is a plain-old germanium diode detector D1 followed by the always popular LM386 IC audio power amplifier.

This receiver also has an AGC stage (U1:A) that controls the gain of the IF amplifier to maintain a constant output range despite the signal level. It works very well. Another useful circuit is the received signal strength indicator (RSSI) U1:B that takes the DC AGC voltage and amplifies it to drive LED D2. This serves as a great visual tuning indicator.

The jack for the headphones or speaker was an odd small size. It didn't fit any of the headphone plugs I had and I still have not been able to find one like this. I just soldered a small speaker to the board and this worked fine.

The big decision you have to make in building this receiver is what frequency range to select. I didn't have a clue so I opted for the Ramsey recommendation of 6 to 11 MHz. I wasn't disappointed. There is lots to listen to in that range. You have to adjust the local oscillator with its slug-tuned coil to cover the entire range, but that is easily accomplished as long as you don't put the receiver in its case.

I connected up 20 feet of #22 solid hook-up wire for an antenna then attached a nine-volt battery, and the receiver came to life. Tuning is intuitive and the band was full of signals. You do have to adjust the IF coils for optimum perform-



*** General Tuning Range Selection Guide ***

C16 = .001	T3 Slug In	T3 Slug Out
C15 = None	6.5 – 13.0 MHz	9.0 – 18.3 MHz
C15 = 47 pF	5.1 – 7.9 MHz	7.1 – 10.7 MHz
C15 = 100 pF	4.3 – 5.3 MHz	6.0 – 8.3 MHz
C16 =100 pF	T3 Slug In	T3 Slug Out
C15 = None	8.4 – 14.2 MHz	11.5 – 19.5 MHz
C15 = 47 pF	6.0 – 8.1 MHz	8.5 – 11.0 MHz
C15 = 100 pF	4.9 – 6.3 MHz	6.7 – 8.4 MHz

Slug In = Fully Turned In CW
Slug Out = Fully Turned Out CCW

All Transistors are 2N3904 NPNs.
Resistor values in Ohms.
Capacitor values in MicroFarads unless otherwise indicated.

Figure 1

ance. I just tuned in a weak station then peaked the coils for maximum output using the plastic screwdriver supplied with the kit.

As for performance, I heard lots of stations. The receiver is not that selective so it was a bit difficult to separate closely adjacent stations, but that is normal for low-cost receivers. That didn't take away from my listening pleasure. I just wish that it was easier to change frequency ranges.

Ten-Tec Model 1054

This receiver was also very easy to build. The instruction manual was clear and I did not encounter any problems. Again, it took me about three hours.

The 1054 is a regenerative receiver. It uses a regenerative detector circuit that is essentially a high gain RF amplifier to which has been added some circuitry to provide positive feedback. Yes, that's right, positive feedback. The kind of feedback you use to make an oscillator. In this case, you apply feedback for the purpose of increasing the gain of the amplifier and improving its selectivity. The more feedback you give it, the closer you come to the point of oscillation. At some point right before oscillation, the circuit Q is very high and the selectivity narrows significantly. The trick is to be able to control the feedback sufficiently to make it easy to get the desired selectivity without the circuit "plopping" into oscillation at which point it becomes more of a transmitter than a receiver. Regenerative receivers let you continuously control the bandwidth of the receiver to eliminate interfering signals and to adjust to the varying signals.

A schematic of the 1054 is shown in Figure 2. It uses a broadband JFET RF amplifier Q1 at the front-end to boost signal level before it is applied to the regenerative detector. The detector is made of two JFETs Q2 and Q3 in a circuit that permits good control of the feedback for easy adjustment. The frequency is set by L1, C3, or C4-C5 and D1. D1 is the varactor tuning diode. The detector output drives a single transistor audio preamp Q4 and then the ubiquitous 386 IC audio power amp.

As for tuning, the frequency ranges are selected by a pair of binary push-button switches S2 and S3 on the front panel. The ranges are 5.9 to 6.4 MHz, 6.9 to 7.4 MHz, 8.5 to 10.2 MHz, and 11.5 to 16.5 MHz. Continuous band tuning is performed with a pot that varies the bias voltage on varactor diode D1. The two lower frequency bands had lots of activity, but the two upper bands were pretty dead. I couldn't tell if that was a receiver problem or just dead bands.

Using the 1054 takes a bit of practice. After you select a band with the push buttons, you begin tuning with the varactor control. Then you start "playing around with" the REGEN control. As you zero in on a station you want to listen to, you tweak the REGEN control until you increase the signal strength and narrow the bandwidth sufficiently. As you near the oscillation point, the bandpass decreases significantly thereby decreasing the noise level and eliminating adjacent interfering signals. If you go too far, you get audio distortion from sideband clipping. It is that selective. What you do then, is adjust the REGEN level and volume to get the best signal.

Overall the regeneration works pretty well. Occasionally you will slip up and the circuit will go into oscillation, but you will know this immediately since reception stops. All it takes to recover is to back off on the REGEN control. The more you use the receiver, the more skilled you will get at tuning and adjusting the controls. Oh yes, one last thing. By putting the detector into slight oscillation you can also listen to SSB signals. And you can hear CW signals, as well because of the beat effect of the detector and the signal.

Frankly, I was amazed at all the stuff I could hear. Again all I used for an antenna was the 20-foot piece of hook-up wire, but the receiver gain is very high making very good worldwide reception possible. The performance is truly exceptional for such an inexpensive and simple receiver. I have no reservations in recommending this kit or the SR2 as a good starting point for someone who wants to get familiar with short-wave listening and have some fun building a kit.

I do have several nit picks about the receiver. First, this receiver requires two nine-volt batteries. The biasing of the FETs seems to require it. The SR2 gets by with one. And third, there is no way to know what frequency you are listening to. But that is not the fault of this receiver any more than any receiver kit selling for less than $30.00.

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793 Canning Parkway
Victor, NY 14564
716-924-4560
www.ramseyelectronics.com

Ten-Tec, Inc.
1185 Dolly Parton Pkwy
Seiverville, TN 37862
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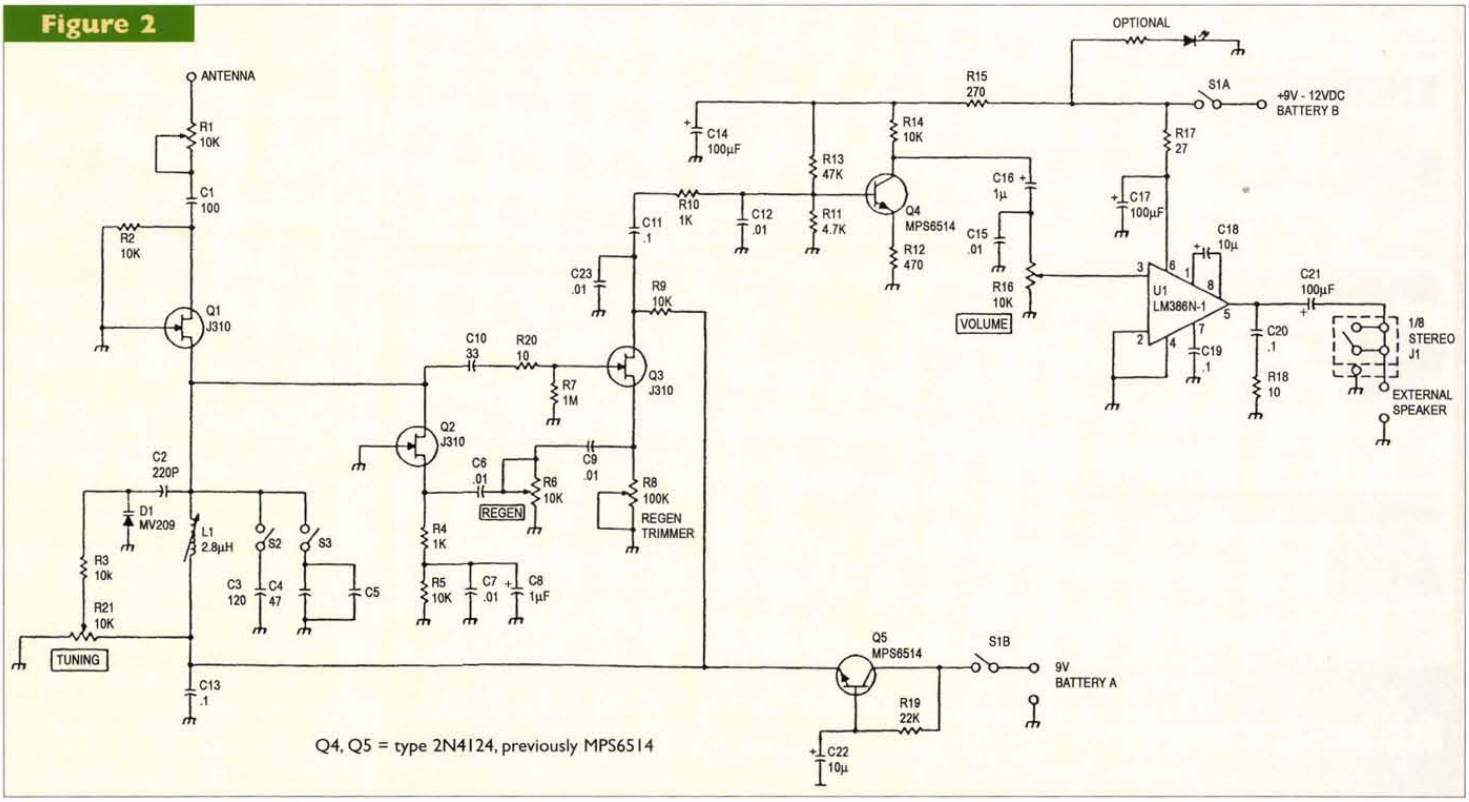
Figure 2



Conclusions

Both receivers worked really well. I definitely think they are both worth the money. A fun project that really pays off in listening enjoyment. And both are pretty easy to build so don't hesitate to dive right in and give it a try even if you are a beginner.

The two receivers couldn't be more different. One is a regenerative detector and the other a superhet. You can hear SSB and CW signals with the 1054, but not with the SR2. This might be a disadvantage if you are a ham, but most of the stuff you will hear on these shortwave frequencies is AM radio anyway and the SR2 really excels at that.

Tuning is simpler and more traditional with the SR2 since you don't have to mess with a REGEN control. On the other hand, the regeneration feature really helps with selectivity problems. Both receivers have super gain and get the most with a very small antenna. I can't help but wonder what these receivers would hear with a 100-foot wire outside.

The two batteries in the 1054 really put me off as did the fact they were not mounted in clips on the PCB. The SR2 used one battery in a neat clip on the PCB. I also liked the small enclosure that was supplied with the SR2. It was simple and inexpensive but still a nice touch. You can buy an accessory enclosure for the 1054 at extra cost if you really need one.

As for tuning, the 1054 wins. You can easily change bands with the front panel push buttons. With the SR2, you are stuck with the band you select when you build the kit and you also have to retune the local oscillator coil with its variable core to cover the entire range. You can always change out the local oscillator capacitors, of course, but it means unsoldering some parts and putting in different ones.

If you are looking for a good week-end project, this may be it. If you have never listened to shortwave before or even if it has been some time since you listened, be prepared to be surprised at how interesting it is. Just don't get addicted to the short-wave or the rosin smoke like I obviously did. **NV**

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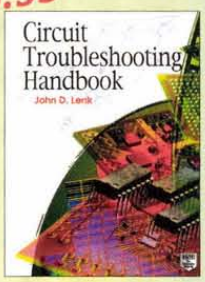

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HAM RADIO OPERATORS —WHO NEEDS THEM?

By Gordon West

Okay hams ... don't come out shooting ...

Okay, hams, don't come out shooting until you get halfway through this article and see that there is a national agency that regularly makes good use of our unique wireless communications of voice, data, video, and automatic position reports. But stick with me as I break the news to you that many well-equipped cities are saying exactly the same thing — Hams ... who needs 'em?

BC (before cell phones), amateur radio emergency communications were an integral part of most city disaster plans. Ham communications were so important that many cities and counties recruited ham operators as technical reserve officers. We were special — without needing to drop a quarter in the phone machine or tie up the city low-band or high-band channel, we could get communications back to central dispatch on an alternate circuit loud and clear. And most amazing ... we could even do it with a handheld radio.

Amazing then, but no longer impressive now. Major municipalities now operate on encrypted digital networks, analog back-ups, and tertiary back-up local government channels. They also have suitcases full of their older PD and fire radios, and in an emergency, the UHF simplex capabilities should serve them quite nicely.

Amateur radio operators will acknowledge the all new digital systems as ultra-modern, but there is always that once chance that the entire system would go down and the city would once again need the ham operators to serve as radio back-up.

"Fat chance on using hams — I am an amateur operator myself, but our local county agency has so many back-up radio systems we wouldn't consider for a second calling in a handful of radio operators who have absolutely no idea how our countywide system works," comments the communications director at a South Florida multiple-county communications center.

"Our technology here at our control room has so many multiple back-ups that a ham operator with his little FM handie-talkie would be of little use to us. Further, his signal wouldn't even make it out of our block house, either!"

But just down the street at the National Weather Service in Florida, amateur radio operators play an important role in staying in constant contact with maritime mobile radio operators who automatically beacon their position on a screen and send weather advisories.

Red Cross Communicators begin a radio set-up at a shelter.

Red Cross Communicators set up a command post for the mobile canteen.

"No cell phone is going to work out 300 miles south of Key West," comments a ham operator who regularly transmits weather reports back to the National Weather Service when tropical depressions begin to form up in August.

In the Midwest tornado corridor, ham radio operators and SkyWarn funnel cloud spotters will many times radio in funnel cloud activity reaching to earth before sophisticated Doppler radar can confirm a touchdown.

"The last tornado that blew through here in Arlington, TX, was actively and accurately tracked by mobile ham operators transmitting directly to our weather service control room," comments Larry Pollock K5IWF, with the W5YI Group.

"The ham operators were spotting the storm cells while simultaneously relaying local atmospheric conditions," adds Pollock, saying that the ham radio operation for the National Weather Service Storm Center was crucial to potentially saving lives.

WANT TO BE USED?

If you live in an area where hurricanes, snow, or tornados might take out local emergency communication systems, check with local ham clubs and see which one has the "in" with the city, county, or state emergency groups. Find out if that local or county emergency group regularly sees action. If you're fortunate enough to live in an area regularly pounded by weather conditions, here is an area where ham radio operation shines.

Okay, this takes care of about one-third of our country's 3/4 million hams — you live in an area where ham radio operators regularly see emergency communication action.

Now for the rest of us — the two-thirds of the country that have such excellent city and county and statewide communication links that there is little for the ham operator to do (other than yakking and having a great time over the airwaves). Any ham operator worth his or her salt loves the feeling of being there to handle emergency communications when disaster strikes. But when disasters strike big cities, the hams are usually last to be called. After all, who needs them?

Joining amateur radio emergency groups like ARES, RACES,

MARS, USCGA, and other emergency organizations may not necessarily guarantee any real call-ups. Sure, you will do parade communications, air shows, parking control, benefit walks, but when the big one hits, you may or may not see your local city or county agency calling you in to handle comms at their emergency dispatch center.

WHO NEEDS US? — I HAVE THE ANSWER!

Both the American Red Cross and the Salvation Army are regularly called up for the big one. In New York hours after 9/11, both American Red Cross and Salvation Army amateur radio operators were on the air, many operating so close to Ground Zero they had to put on their air filtration breathing masks. The Salvation Army calls their radio network SATERN, and I encourage them to follow up in *Nuts & Volts* with a full-length article about all the good that they do. They have a big story to tell, and I guarantee SATERN operators regularly see action.

Here in Orange County, CA, I am a communications volunteer for the American Red Cross, Orange County Chapter. Red Cross is where the action is! "The American Red Cross responds to disasters such as hurricanes, floods, earthquakes, fires, or other situations that cause human suffering or create human needs that those affected cannot alleviate without assistance," comments the author of ARC 4450.

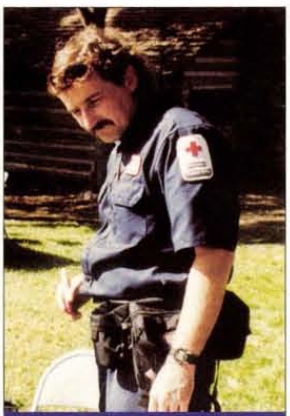
"The American Red Cross is not a government agency," is a major statement that focuses squarely on the volunteer efforts of local ham operators to support their chapter radio communications program. As volunteer ham radio operators for our local chapter, we get plenty of real action call-outs, continuous free training, access to the chapter's radio room and mobile radio units, and opportunities to move around as volunteers within the chapter to do more than just provide ham communications. Most American Red Cross chapters throughout the country have only a handful of commercial radio channels allocated to them.

47.42 MHz Nationwide low-band FM
47.46-47.66 MHz Additional secondary channel
154-155 MHz High-band channel
One or two UHF 462 MHz Business band channels

Since the American Red Cross is not a city, county, government, or state agency, getting additional radio channels is tough. And getting on a channel clear of local congestion is even tougher!

"Here in Orange County, CA, our Red Cross amateur radio operators work closely with local repeater organizations, such as CLARA, so we can come up on their repeater in an emergency situation to handle radio traffic off of congested Red Cross channels," comments Larry Wilson K6SCH, Communications Chairman for the Orange County Chapter of the American Red Cross.

"Almost all of our radio communicators are licensed hams, so we have plenty of channels and megahertz of simplex frequencies we can use for voice, data, automatic position reporting, fast-scan television, slow-scan television, radio teleprinter, packet, or just about anything else we need to send over the airwaves," adds Wilson.



Red Cross Communicators (KC6YNG) operate with only battery power on their belt!

Every chapter in the country would love to have all of the frequencies and bands that ham radio operators have, and they have complete access to these bands and frequencies if each chapter works up a communications unit staffed by licensed amateur radio operators.

The most common Red Cross communications are between their mobile units at the scene of a disaster or shelter with radio traffic back to the local chapter headquarters. These radio comms might be the ordering of shelter supplies, canteen equipment needed at the scene, head count for mass feeding, head count for shelter staffing, and all of the many other pieces of radio traffic during an emergency response. Amateur radio communications would not be permitted for the day-to-day routine activities of normal chapter "business." Here the chapter would use their own business-band radio system.

Many American Red Cross responses are to a disaster area where the cellular network has been knocked out. This will be ham operation at its best! Or sometimes the shelter operation may take place in an area not served by a major cell site, and the cell phone system locks up with too many local calls. Ham radio sails through cell phone lock-ups!

The ham operators serving their local chapter of the American Red Cross must take classes before they are issued their American Red Cross ID tag:

- Introduction to Disaster Services
- Mass Care — An Overview
- Damage Assessment
- Emergency Assistance to Families
- Disaster Communications Workshop (chapter specific)

Sometimes Red Cross Communicators (KF6VTV) do double-duty!

Hams who are trained in medical fields like nursing or emergency medical technician may wish to take additional classes, such as disaster action team or disaster health services. If you are a ham operator and tired of training and rehearsing for real action, joining your local Red Cross unit will put you into the hot bed of real scene action as soon as you take your classes and become proficient on your local chapter's radio operating procedures.

The chances of you getting regular call-ups to local disasters is 100 out of 100 — almost every local disaster has a call-out for the American Red Cross to provide meals, shelter, temporary displacement shelter, relocation, and a myriad of other services to our clients. The police and fire agencies welcome the American Red Cross participation in the local disaster because they know that big white van followed by your communications vehicle is stocked with cold water, hot coffee, snacks, and for big events, hot meals all day and all night long. "We welcome the Red Cross volunteers because we know all that the American Red Cross has to offer in the field, right at the site of the incident," comments a fire captain in Orange County, CA. And you will receive the same response anywhere else in the country when working as a card-carrying active member of the American Red Cross communications team.

But it requires diligence on the part of any ham joining a Red Cross comm unit. Every month, you may have a couple of meetings, plus an every-other-month shelter exercise. You'll have plenty of opportunities for classes offered by your local chapter. You will be able to equip your headquarters with radio donations that regularly pour in — excess radios might be assigned to active communication team members regularly going out on calls. But to stay a regular team member with our local chapter, you must actively check into weekly nets, attend those required monthly meetings, and participate in a minimum of three or four shelter drills each year. And the rest of the time, you sleep with that pager knowing that the next call will indeed be a real one — not just a drill — and your assignment might be just feet away from the disaster impact point.

To learn more about your local American Red Cross chapter and their needs for licensed ham radio operators or non-ham radio communicators, visit the website at www.redcross.org, and contact your local American Red Cross chapter and ask for the phone number of the ham radio operator in charge of chapter amateur radio communications. **NV**

Author West writes this month's editorial column based on two decades of local city, RACES, MARS, and ARES groups who regularly trained but never saw any meaningful action. He found the most acceptance of amateur radio emergency communicators in the well-equipped big city with the American Red Cross and Salvation Army radio groups. Any SATERN reader wanting to write about the Salvation Army communications unit, send your story to Nuts & Volts! Any ARES or RACES members who regularly see action are also encouraged to write their story and submit it to Nuts & Volts, or write the author at ***wb6noa@arrl.net****.*

The dealers listed below carry the latest issue of Nuts & Volts, for your convenience.

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Tullamarine 3043
www.dontronics.com

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5611 Blackstone
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Troy 48098

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Western Test Systems
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Electronics Q&A

With TJ Byers

In this column, I answer questions about all aspects of electronics, including computer hardware, software, circuits, electronic theory, troubleshooting, and anything else of interest to the hobbyist.

Feel free to participate with your questions, as well as comments and suggestions.

You can reach me at: **TJBYERS@aol.com** *or by snail mail at Nuts & Volts Magazine, 430 Princeland Ct., Corona, CA 92879.*

What's Up:

Solar temperature controller, solar books, and stereo fan cooler. Soiled inkjets, electronic symbols, and sexing transistors. Also a low-power version of a constant current source, long-life bulbs, and free CAD programs.

Solar Pump Controller

Q. I am in the process of building a solar water heating system and need plans for an adjustable comparator circuit to control a circulating pump. When the upper limit temperature is reached, the pump will start and when the lower level temperature is reached, the pump will shut down. To make the circuit usable in a number of different applications, it would be helpful if the high and low set points were adjustable. Not being in the electronics field, I could use as much detail on the individual components as possible.

Greg Milley
via Internet

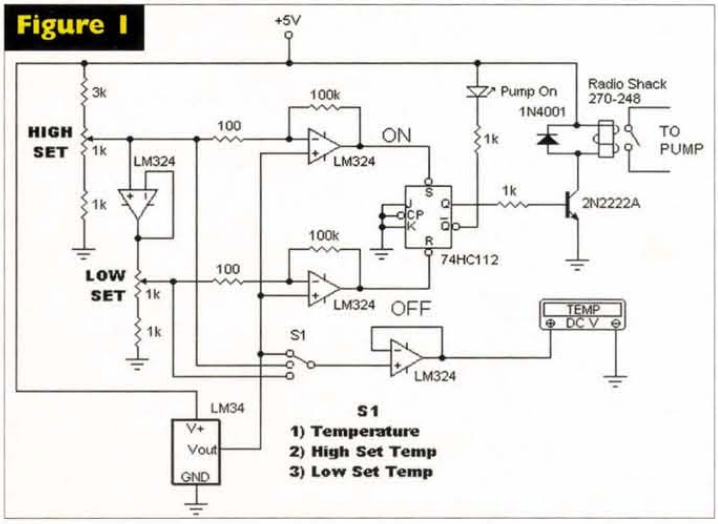
A. If you want a quick and relatively cheap solution, Thermo Technologies **(410-997-0778; www.thermotechs.com/usdt2001.htm)** makes a microcontroller-based temperature controller specifically designed for solar water heating systems. But I know you want to build it yourself! So here you are. (Figure 1)

The sensor is an LM34 — a precision temperature sensor with a linear output of 10mV per degree Fahrenheit. At 100 degrees, the LM34 outputs a voltage of 1.000, which can be displayed directly on a DVM with no calibration. This voltage is fed to a pair of LM324 op-amps operating as comparators. The High set point is determined by the upper comparator and the Low set point by the lower comparator.

To prevent the set points from crossing over each other (where the Low set point is higher than the High), an LM324 buffer amp is used to set the range of Low set which, in this configuration, can never exceed High set — only equal it. To provide the necessary temperature differential, the output of the comparators controls an RS flip-flip, which can only trigger on the transition of the comparator outputs, not their absolute state. The output of the flip-flop, in turn, drives a pump relay and "Pump On" LED indicator.

Because the output voltage of the LM34 sensor is directly proportional to the temperature, calibration is done using a DVM or DMM set to the two-volt range. A three-position rotary switch (like the RadioShack 275-1385) selects the DVM to read the current temperature, and the High and Low set points. You can make the DVM a permanent part of the controller using a panel voltmeter, like the **Jameco** #108388 **(800-831-4242; www.jameco.com)**. In fact, all components (including a suitable relay substitute) can be purchased from Jameco.

Figure 1



Solar Books

Q. Do you know of a good, practical book on solar power? I have some ideas about using it for home use, but I first need to find out about the capabilities of solar power in order to really apply it to our appliances.

Gill Nascimento
via Internet

A. Here you go. Last time I checked, all were still in print and available from **Amazon.com**.

**The Easy Guide to Solar Electric: For Home Power Systems* by Adi Pieper.

**The Real Goods Solar Living Sourcebook: The Complete Guide to Renewable Energy Technologies and Sustainable Living*, by John Schaeffer (Introduction), Douglas R. Pratt (Editor).

**Achieving Energy Independence — One Step at a Time*, by Jeffrey R. Yago.

**Using Sunlight For Your Own Solar Electricity: Build Your Own System, Become Independent of The Grid, Domestic Photovoltaics*, by Ralph W. Ritchie.

**The Evolution of an Independent Home; The Story of a Solar Electric Pioneer*, by Paul Jeffrey Fowle.

**The New Solar Electric Home: The Photovoltaics How-To Handbook*, by Joel Davidson.

**The Solar Electric House: Energy for the Environmentally-Responsive, Energy-Independent Home*, by Steven J. Strong.

Fan Controller

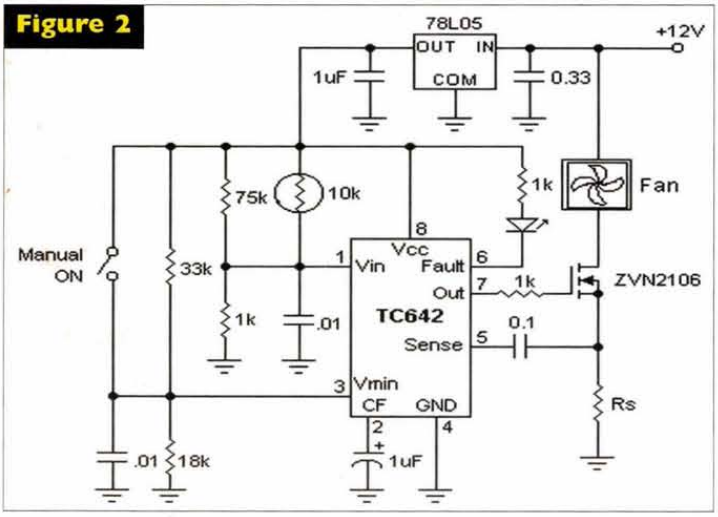
Q. I am in need of a circuit to control a relay to operate a fan to come on at a pre-set temperature and to cut off at a lower temperature set point. The circuit will control a mini-fan (AC or DC) to cool my stereo equipment. I would also like to have a manual override where the fan would be on all the time. The circuit board will probably be mounted independent of the fan in a small housing, so I'd like for my options to be as flexible as possible.

Brad King
Paris, IL

A. You can always use the circuit shown in the answer above, "Solar Pump Controller," but I'd use a fan controller chip like those used in PCs. After looking over the choices, I decided that the TC642 from Microchip would be the best choice for your application. Not only does it control the on and off operations of a cooling fan, it also has a speed control that slows down and speeds up the fan as needed to reduce noise and conserve power. (See Figure 2)

I don't know the size of the system you need to cool, so you're gonna have to help me with your design. First, let's start with the fan itself. It has to be a

Figure 2



two-terminal, brushless PC-type fan with enough capacity to satisfy your cooling needs. Don't worry, you have plenty to choose from — you can even rescue one from a trashed PC power supply. The operating current of the fan is a determining factor in the design of this circuit, because it has a Sense input that makes sure the fan is spinning via a sensor resistor, Rs. If the fan stalls or malfunctions, pin 6 goes low, which causes the LED to light. You can use this open-collector output to perform a number of safety functions, like turn off power to the stereo system or sound an alarm. The value of Rs is determined by the operating current of the fan, as listed in the following chart.

Rsense vs. Fan Current

Fan Current (mA)	Rs (ohms)
50	9.1
100	4.7
150	3.0
200	2.4
250	2.0
300	1.8
350	1.5
400	1.3
450	1.2
500	1.0

The second consideration is the thermistor, which can be located a distance from the board. Any 10k thermistor will work, but since **Digi-Key (800-344-4539; www.digikey.com)** is one of the few hobbyist suppliers of the TC642, I thought you may wish to buy the thermocouple from them, too. The catalog number is KC006E-ND.

To have a manual override where the fan is at 100% all the time, all you need to do is apply 2.65 volts to pin 3, the Vmin input. Let me explain something about this pin. This input will set the range of the fan speed, and you can adjust it between 1.25 volts, 0% voltage to the fan, and 2.65 volts (100%). This doesn't override the thermistor, but limits its range. However, if you tie it high to Vcc, the range is between 100% and 100% — hmm, sounds like full on to me.

I'm assuming that you will be driving this circuit from 12 volts, which is a typical fan voltage, so I've added a 78L05 voltage regulator to run the TC642 chip. This also lets you run fan voltages up to 35 volts from the same regulator with no change in the circuit. There's nothing better than cool music!

It's A Dirty Job, But ...

Q. Is there a household chemical like alcohol, Windex, 409, or something that can be used to soak the printhead on inkjet cartridges to dissolve the dried ink in the jets to get the cartridge to print again? Printer repair shops use something to clean print heads. What is in it?

Curt Powell
via Internet

A. This question has two answers, depending on whether the printhead is integral to the cartridge itself (built-in) or not. With up to 144 microscopic inkjet nozzles, printers can quickly develop dried ink residue and minute air bubbles that block up the printheads. Over time, these build-ups in the ink nozzles will damage your printhead — particularly when subjected to irregular use.

For those printers with separate printheads, like Epson, the answer is a printhead cleaning cartridge. Using a safe solution of specially formulated solvents and detergents, the cleaning cartridge is able to clean the whole printhead quickly and thoroughly. The chemical mixture is made from the base materials of the inks (glycerin, alcohols, diols, and/or water) to help make dried ink soluble and carry away insoluble materials. Because each printer manufacturer uses a different ink formula, each printhead requires a different cleaning solution. Fortunately, cleaning cartridges are rather cheap and can be used more than once. Here's a short list of those people who sell them.

www.northantsnet.co.uk/inkshop/Cleaning%20Cartridges.html

www.inkdaddy.com/products/4ink/Inkjet_Cleaning_Cartridges.html

www.falconsafety.com/dustoff/office/c&c_faq.html

For those printer cartridges with built-in printheads, like HP, it's sometimes possible to clean a cartridge which has a printhead that's blocked up. Place the printhead part of the cartridge only in a saucer containing 50% boiling water and 50% ammonia for up to 30 minutes. This should hydrate the dried ink enough to allow the ink to flow again. It's preferable to do this when the cartridge is empty, after which you should immediately put a small volume of ink into the cartridge to test the print quality by inserting the cartridge into the printer and running the printer through its printhead cleaning cycle. Note that this procedure can only be performed a few times before the cartridge is distorted by the hot water or simply wears out.

Electronic Symbols & Notations, Again

Q. In the Feb. 2002 issue, Ray Marston wrote a very fine article on triacs with lots of good information that I will use. However, I have questions about his labeling of components. He has resistors labeled 100R, 2k2, 1k0, 3k3, and 4k7. The caps are labeled 100n and 100u, which I assume stands for nF and uF. Is this correct? Figure 10 shows two zener diodes labeled 5V6, and Figure 19 has an R2 and C1 without values. He doesn't cover this in the text. Any help will be appreciated.

Al Izatt
via Internet

A. At first European component labeling can be confusing, but it all makes perfect sense. Let's take resistors first. When we, in the States, want to specify a 4700-ohm resistor, we label it 4.7k; in Europe it's labeled 4k7 where the multiplier takes the place of the decimal point. (Decimal points often don't print well, so this avoids confusion.) If the resistor is labeled with a capitol R, as in 100R, it stands for ohms (100 ohms). The same for the zener diode, where 5V6 stands

Cool Web Sites!

In TCP/IP and UDP networks, a port is an endpoint to a logical connection (address). Some ports have numbers that are preassigned to them, and are known as well-known ports. This **Webopedia** site lists port numbers for reserved privileged services.

www.webopedia.com/quick_ref/portnumbers.html

FreeAnswers is a web site that offers AnswerWorks natural-language access to several manufacturers' knowledge bases, notably Microsoft's. When it comes to finding what you need, FreeAnswers beats the pants off the search engines provided by Microsoft and others.

www.freeanswers.com

Into robotics and want to learn about geometry, kinematics, and dynamics? Download the latest version of **FreeCAD 5**, a 3-D CAD software package with advanced motion simulation capabilities that can be applied directly to robotics design and testing. It's simple to learn, easy to use, and it's free!

ftp://nutsvolts.com/freecad5.zip

for 5.6 volts.

You are correct that 100u = 100uF and 100n = 100nF. However, we don't commonly use nF, so the value 100n would translate to 0.1uF. Ray Marston wrote an excellent article on "Electronic Symbols & Notations" that you can download from our web site at: **www.nutsvolts.com/PDF_Files/circuit.pdf**.

Transistor Pin Identification

Q. Can you point me to a web site that explains how to identify the emitter, base, and collector from looking at the package? I can never remember if the arrow is the emitter or collector. I always have problems with this.

Greg Lehmann
via Internet

A. Yes, here is a web site that will deliver what you want.

ftp://nutsvolts.com/symbols.pdf

If you're having a hard time remembering which is which, imagine the emitter lead of the transistor as being a garden hose. The emitter line has an arrow on it; think of the arrow as the hose's nozzle. What does a garden hose with a nozzle do? It emits water, therefore it is an emitter.

There are certain transistor packages that also have clues as to which leads are the emitter, base, and collector. Unfortunately, most of these are of the metal case type, which are quickly giving way to epoxy plastic packages. Nonetheless, it's worth mentioning as shown in Figure 3.

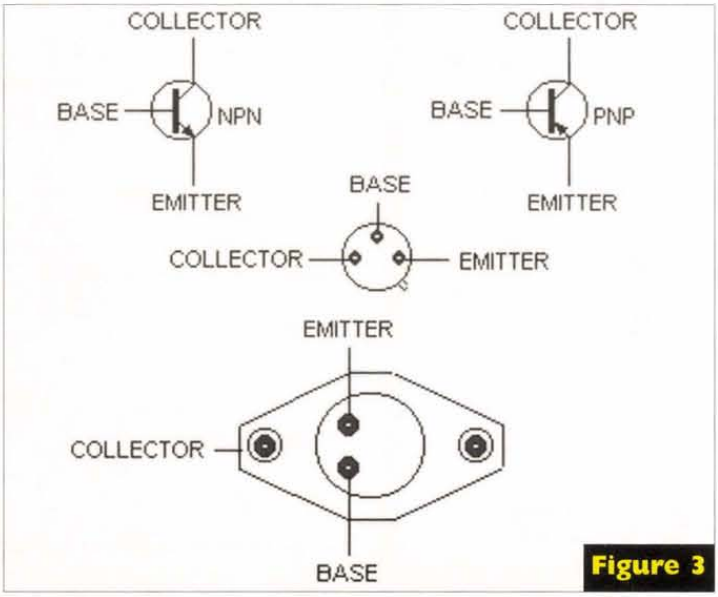


Figure 3

Low-Power Constant-Current Source

Q. In the Mar. 2002 column, you described a constant-current source. I have not been able to duplicate your results while attempting to obtain a constant source of about 35 mA from a nine-volt rechargeable battery. I tried the circuit using an LM317 voltage regulator and found that the output current varied widely with the input voltage. I didn't have a one-ohm rheostat, so I used a fixed one-ohm resistor. Perhaps you could expand on your explanation for the benefit of dummies like me!

Dan Cassidy
Findlay, OH

A. There are no dummies when it comes to designing a circuit, just those who are unclear on the rules. In your case, you're trying to regulate a measly 35 mA from a regulator that's designed to regulate 1.5 amps. In fact, if you run the numbers through the LM317 equation (shown in figure 4), you'll discover that one ohm sets the regulator output at 1.25 amps. That's why your output current is all over the place — it doesn't match your light load.

Your application needs a 78L05 which has a current regulation range of 15 mA to 100 mA (Fig. 78L05_CURR.BMP). The design is essentially the same except for the resistor values, which I've calculated for you in the table below.

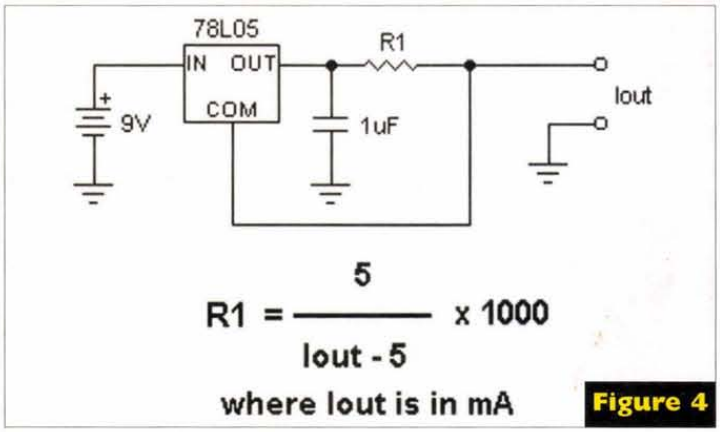


Figure 4

Current (mA)	R1
15	500
20	330
25	250
30	200
35	166
40	140
50	110
60	91
70	75
80	68
90	60
100	53

Simple Schematic Drawing Program?

Q. What program do you use to draw the schematics that appear in "Electronics Q&A?" I am looking for a simple and inexpensive PC program.

Dave Saum
via Internet

A. I use CircuitMaker 2000. You can download a student version for free at **www.microcode.com**.

Long-Life Lamp

Q. Many people are replacing their old Edison-type incandescent light bulbs with the new compact fluorescents with a considerable savings in energy and extended lamp life. The problem is that many times the fluorescent lamp won't fit in the existing fixture — they are too long.

I've heard that an Edison bulb will last a long time if operated on 120-volts DC, and wonder how hard it would be to convert the fixture from AC to DC. Could I do this using a round transformer and a small bridge rectifier? This would mean that the bulb would see pulsed DC and last a lot longer with no loss of light output.

Stuart B. Wahlberg
Blythe, CA

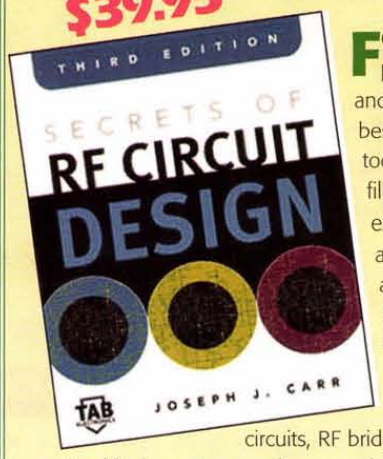
A. It's an interesting proposal, but it won't work the way you think. When operated from a DC source, a small percentage of the tungsten atoms that evaporate from the filament become ionized. This causes the positively-charged atoms to be attracted to the negative post, resulting in a mechanism that may cause uneven filament evaporation that can lead to a shorter — not longer — lifetime. However, the difference between AC and DC operation is too small to be of concern or value. So don't start modifying your lamp sockets anytime soon.

One popular practice that does work to extend bulb life is to insert a single diode in series with the lamp to produce pulsating half-wave DC voltage **(www.lightingresource.com/litesaver/mellin.asp)**. The theory is that by cutting the voltage in half, you cut the power consumption in half and extend lamp life. Kind of a poor man's fluorescent "lamp."

A diode lets current through in only one direction, causing the bulb to get power only 50% of the time, which effectively reduces the applied voltage by about 30%. While the bulb life expectancy is increased dramatically, the power consumption is reduced by only 40% (not 50% because the cooler filament has less resistance, and draws more current) and light output is reduced by about 70% (cooler filaments are more efficient at radiating infrared light in the form of heat than they are at radiating visible light). To compensate for the light loss, you can put a 100-watt bulb in place of a 60 watt or a 150 watt where you

Secrets of RF Circuit Design

$39.95 by Joseph J. Carr



Following up on the best-selling previous editions, this revised and updated guide gives you the best ways to design, build, and test today's radio frequency circuits. It's filled with functional projects and experiments that make it easy to apply RF principles to real-life applications. Joe Carr provides parts lists and component sources for every project, in chapters that cover how to: Design and build radio receiver circuits, RF bridges, amplifiers, receiver preselectors, simplified spectrum analyzers, and time domain reflectometers; Select, use, maintain, and repair variable capacitors; Design and wind inductor coils for radio circuits; Construct and ground simple wire antennas.

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Electronics Q&A

want a 100 watt. But it will still have less brightness, a redder color, and isn't recommended for reading lights.

But hang on, there is hope for a little more bulb life with nearly full brightness. Most incandescent lamp failures occur when the light is first turned on. As a lamp ages, electrons literally boil off the tungsten filament, causing the wire to grow thinner. Unfortunately, most filaments don't burn evenly, but have places where the metal is thinner than at others. When voltage is first applied to a cold filament, there's a large inrush of current. If there is a thin spot in the wire, it will heat up faster than the rest of the filament which produces a hot spot — which, in turn, causes electrons to boil off even faster. Eventually, this weak spot will fail and put an end to the bulb, usually in a brilliant flash.

By limiting the inrush current using a method called "soft-start," bulb life can be extended. There are several devices you can attach to the base of the lamp that give you a soft-start. Some use a thermistor that decreases in resistance as the lamp warms up; others have patented electronic devices **(www.galaxymall.com/product/everlastproducts/product2.html)**. However, you can achieve the same results by replacing the wall switch with a dimmer control. The ideal dimmer looks just like the toggle switch it's replacing and can be found at most hardware stores for about $6.00. In addition to extending bulb life, dimmers are great for setting the mood of a room.

Mailbag

Dear TJ:

I believe I have a much cheaper (free) solution to John Siebel's request *(Electronics Q&A, Apr. 2002)*. Simply use an old PC. The cool thing is that the PC can even be an old 4.7-MHz PC (w/o a hard disk) that you can find in the trash can, generally with a monitor (that will stay OFF most of the time).

From the DOS prompt, type the following.

```
Copy con crlf.txt    <Enter>
                     <Enter>
^Z                   <Enter>
```

This will create a file called CRLF.TXT.

Open the file using a text editor, like Notepad, and type in the following.

```
: POWER DOWN
Copy logger.txt + PwrDn.txt
logger.txt

: POWER UP
Echo Powered UP on: >> log
ger.txt
Date < crlf.txt | Find "The
current" >> logger.txt
Time < crlf.txt | Find "The
current " >> logger.txt
:loop

:The next line could be
replaced with a Delay.com
utility

Dir C:\ /s
Echo Powered DOWN on: >
PwrDn.txt
Date < crlf.txt | Find "The
current " >> PwrDn.txt
Time < crlf.txt | Find "The
current " >> PwrDn.txt
GoTo loop
```

Save the file and run it by adding the line

```
Type CRLF.TXT
```

to the end of the Autoexec.bat file. This, too, can be done using a text

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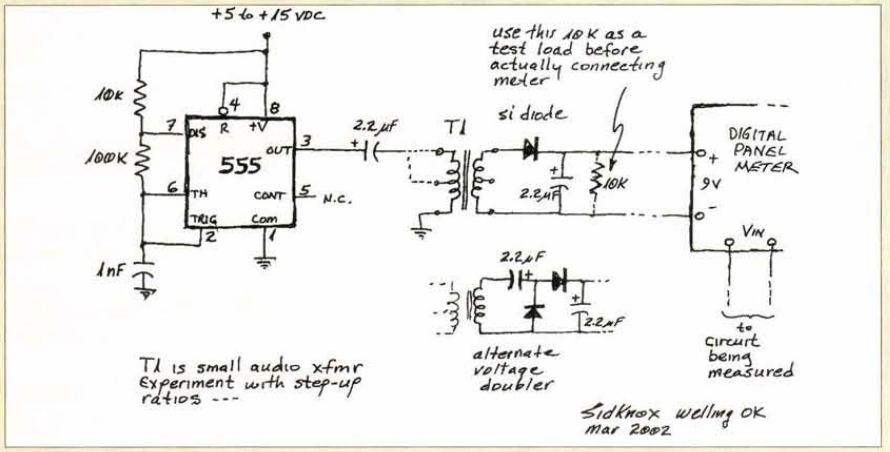
Reader's Tip: Panel Meter Isolation

I've found those low-cost, 3-1/2 digit LCD panel meters — the kind **Marlin P. Jones (www.mpja.com/index.asp)** sells for $7.95 — perfect for a lot of applications, and would love to use them for monitoring power supply voltages in many applications. Unfortunately, the panel meter and the voltage under measurement can't share a common ground. I've read many tricks that promise to fix that problem, but none seem to work.

Even though the power requirements are very small — less than 10mW — I can think of no way to get the isolation needed other than by a transformer. Here's what I've devised (Fig. PanelMeter.gif). I use a small audio transformer that I buy from **Mouser Electronics (800-346-6873; www.mouser.com)** part number 42TL016. It has a 1:1 ratio with center taps on both the primary and secondary. I use the taps to adjust the input voltage to the output to match a wide variety of situations. One further note: If you already have a periodic signal available — e.g., a counter, microprocessor clock, or PWM — the 555 can be eliminated.

Sid Knox
via Internet

Editor's note: *This is definitely an experimenter's circuit, because you have to adjust the values to obtain the nine volts needed for the panel meter, which depend on the clock rate and input voltage. Myself, I'd add a 9.1-volt zener diode (1N4739A) across the DMP's nine-volt battery input for over-voltage protection just to make sure.*



editor. Now reboot the PC.

When there is power to the PC, the program will print a time stamp to the LOGGER.TXT file. If power is lost, there is a space between the last power-on stamp and the new PC reboot time stamp. The difference between the two time stamps will tell you which day(s) and for how long the power was off.

I'm always trying to find uses for older PCs.

Rance
via Internet

Dear TJ:

Regarding your response to "Serial Port Power Revisited" in the Apr. 2002 issue, the answer was factual as far as it goes. But why in all of creation would you try to stretch the power available at a serial port when amps of current are available just on the other side of the sheet metal?

He could easily tap into any of the unused power connectors inside the computer and get 5 or 12 volts with all the current he could possibly use. A small power connector could be quickly installed on the back of the chassis, or a cable could be brought out through one of the numerous holes (add a grommet, please) that exist on the back of every PC. An in-line fuse (0.25 amp or less) inside the case would also be a good idea, and I like the idea of the 78L05 voltage regulator.

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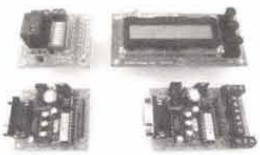

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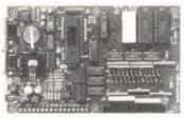

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New Product News

POCKET PHOTO ADVANCE (CJ-200) — 1.3 MEGA PIXEL CAMERA AND VOICE RECORDER

M.E.M. Electronics Co. announces the newest in a line of digital pocket cameras with a four-hour digital voice recorder all in one small package.

The CMTECH, CJ-200 is the first product with a 1.3 Meg digital camera that also incorporates a digital voice recorder to record meetings and annotate still images and video movie clips. The small (2" W x 4.75" L x 1" D) size and lightweight (~98 g) allows this digital camera/recorder to be a splendid device for capturing great images and not miss a word from important business meetings.

For businesspersons, writers, reporters, professors, college students, doctors, and others involved in the knowledge industry.

The CJ-200 can store 250 color, still images (1280 x 1024 pixel) or over 500 lower resolution (640 x 480 pixel) images, 180 seconds of mini-video movies (320 x240 pixel), and four hours of audio with the internal voice recorder and then download them to any PC via USB with the included software.

This unit records on 32 Mbytes of internal flash memory and has a Smart Media card socket for archiving additional images or audio. Added features include a 1.5" color, TFT LCD display providing highly visible and accurate viewing of images prior to recording and playback, optical viewfinder, 3x digital zoom, and NTSC video output jack for playback on any video monitor.

The package includes all the accessories needed for all types of uses. "Picture Station III" software compatible with Windows '98, SE, 2000, and ME. Four "AAA" batteries (included) give hours of continuous use.

Look at our updated web site – **www.memelectronics.com** – to see this new camera with sample images, other voice recorders, and new micro "SPY" cameras, and video transmitter products

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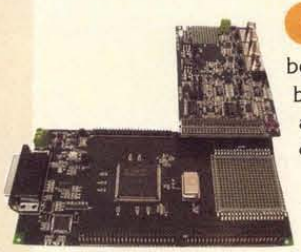

Colorado Electronic Product Design, Inc., is offering its high-speed analog I/O (HSA) board bundled with its Xilinx Spartan®-II-based FPGA development board (CXS200), allowing fast implementation of DSP in FPGA designs.

The HSA — capable of running at 40MSPS — features a simple, parallel interface to the FPGA board, two eight-bit input channels and one eight-bit output channel.

The input channels — from BNC connecters — offer the choice of buffering the input signal and a selection of switched-capacitor or passive anti-aliasing filters.

The output channel, also routed to a BNC connector, can drive a 50-ohm load and offers switched-capacitor or passive reconstructive filters. The board may be powered externally by unregulated DC or by the FPGA host board. The HSA comes with a detailed manual and schematics.

The CXS200 has a Xilinx XC2S200 Spartan-II FPGA with a configuration PROM. All I/O pins are available from connectors, one of which mates directly with the HSA. A swappable 16MHz oscillator is provided. On-board programming circuitry allows the FPGA to be directly programmed from the parallel port of a PC without a special cable. The board includes a prototyping area for user circuits. All software tools necessary to develop designs and program the board can be downloaded free from the Xilinx website. The manual included with the board has instructions for obtaining and setting up the development tools, as well as board information and schematics.

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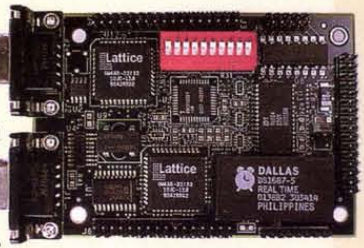

SeaFire Micros, Inc., announces their first in a series of high-feature,low-cost single board computers.

The SF-1000 uses the powerful Atmel Wireless & Micro T89C51CC01 microcontroller. Some features are the CAN controller, eight-channel ADC, up to five PWM outputs, multiple 16b timers/counters/PCAs, watchdog, internal flash, and low power modes.

The SeaFire SF-1000 has additional interfaces, including i2c, RS-232, JTAG, and up to 50 I/O on headers. The SF-1000 has over 290Kx8 FLASH and 256Kx8 SRAM, and has a battery-backed real-time clock.

The SF-1000 measures just 3.80" x 2.63", and has CPLDs for prototyping. The board runs at 20MHz or 40MHz, on 5V.

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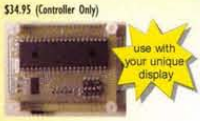

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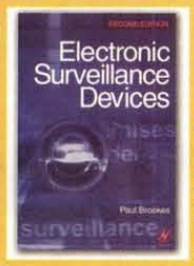

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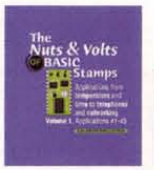

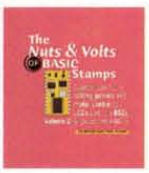

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The GlobeSpan World Band Receiver

By Lyle Russell Williams

You should hear what you've been missing!!

The most unbiased source of international news today is shortwave radio. The propaganda style of the cold war is mostly gone. Stations such as the British Broadcasting Company, Radio Canada, Radio Netherlands, Deutch Welle (Germany), and The Voice of America are supported by governments instead of corporations. The countries are often surprisingly honest about themselves and about the state of the world. For instance, Radio Netherlands frequently talks about legalized prostitution in that country.

Many shortwave stations can be heard on the Internet using Real Audio software, but a fast connection is needed for uninterrupted streaming of audio. News programs are usually offered in five-minute segments which must be selected one at a time. An Internet connection and possibly a phone line has to be tied up while listening. This is a different experience than listening to shortwave radio.

An English language shortwave broadcast can be found almost anytime during the day or night. There are many good shortwave receivers at reasonable prices on the market. The GlobeSpan radio presented here can be home-constructed, it requires little alignment, and its performance is impressive. The radio can receive AM (amplitude modulation), CW (code), and SSB (single sideband) and could be tuned to amateur radio bands with different tuning coils.

History

The original vacuum tube regenerative radio (a representative schematic is shown in Figure 1) was patented in 1914 by Edwin Armstrong. This was the primary design used in the early 1920s for broadcast radios. Because regenerative radios radiated a signal from the antenna that would give away the location of the receiver, they were not practical for military uses. Interference with other receivers also led to the design being supplanted by the tuned radio frequency (TRF) radios in the 1920s. Shortly after inventing the regenerative receiver, Armstrong started working on the superheterodyne receiver which replaced the TRF radios for broadcast receivers around 1930.

The main advantage of the regenerative radio is that a complete receiver could be implemented with a single vacuum tube (using headphones and battery power). The regenerative circuit remained a favorite design for home-constructed shortwave broadcast radios and amateur receivers throughout the 1930s. From the 1940s on, regenerative radios (mostly tube based) have been offered in commercial kits and have been the subject of numerous magazine construction articles. There have been no commercially-constructed versions, probably because of the difficulty of obtaining FCC-type approval on a receiver that is expected to radiate spurious signals.

The superheturodyne receiver has undergone years of research and virtually every receiver today uses this principle. In contrast, the regenerative radio has seen little development and contemporary designs are not much different than the original Armstrong design (similar to Figure 1). The author's regenerative radio presented in the March 1994 issue of *Popular Electronics*, broke with tradition and offered many improvements over the old design. The GlobeSpan radio presented here has additional technical and cosmetic improvements over the 1994 version. A list of improvements is given in Table 1.

Appearance

The GlobeSpan was originally conceived as a vacuum tube radio. Vacuum tube designs are costly and finding suitable parts is often difficult. A transistor design was subsequently chosen, but cosmetic factors were manipulated to give the radio an old fashioned appearance. The "breadboard" type construction popular in the 1920s was used. The name "GlobeSpan" was chosen to sound like but not duplicate any of the commercial radio names of the past (Transoceanic, Ocean Hopper,

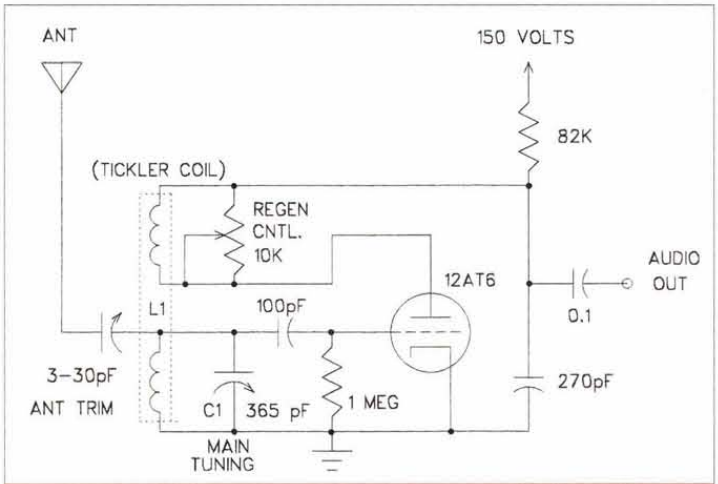

Figure 1: Traditional tube-based regenerative receiver.

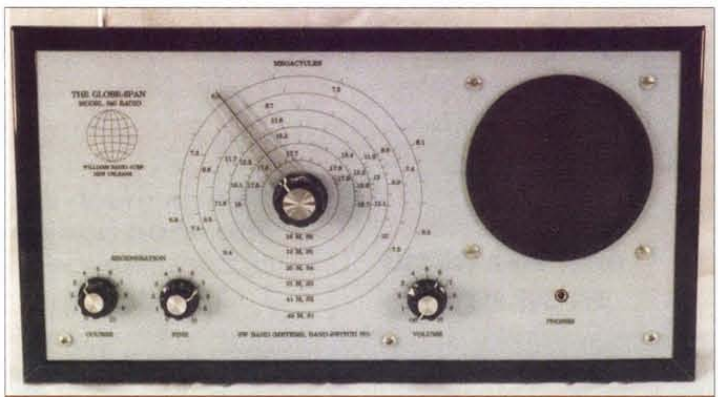

Figure 2

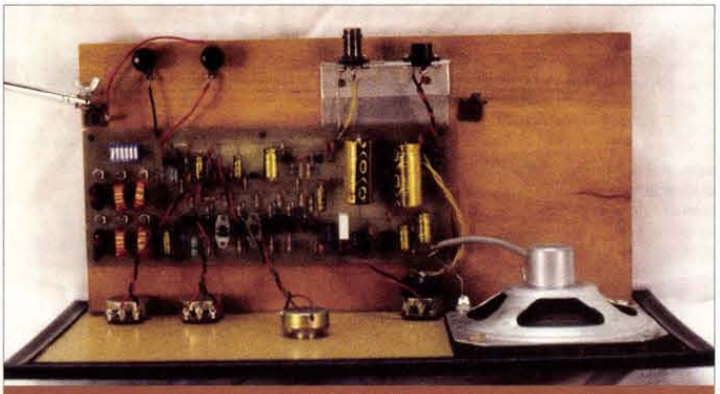

Figure 3

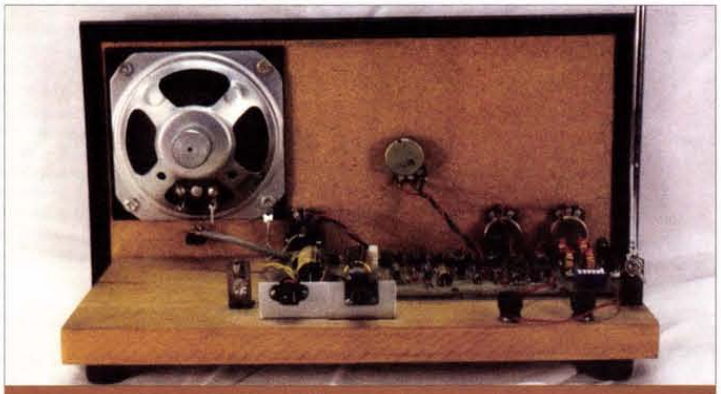

Figure 4

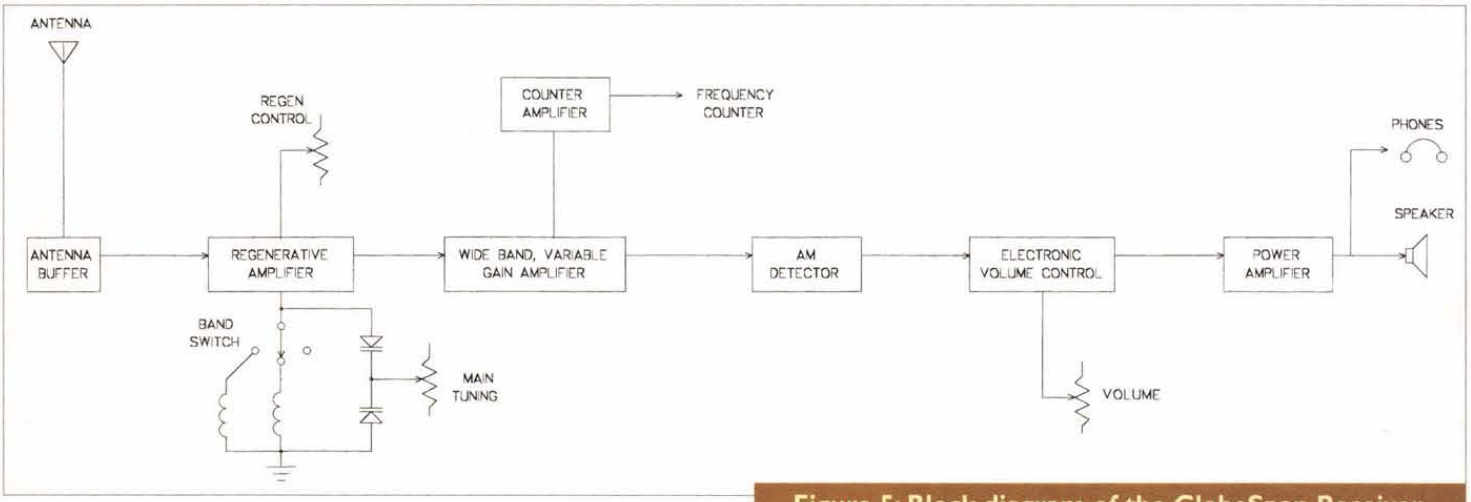

Figure 5: Block diagram of the GlobeSpan Receiver.

Table 1: GlobeSpan Receiver Improvements

1. In traditional regenerative receivers, the antenna was connected directly to the tuning circuit through an antenna trimmer capacitor (see Figure 1). Oscillations from the receiver would be radiated from the antenna. Antenna isolation in the GlobeSpan greatly reduces radiation.

2. Because of the antenna connection mentioned above, when the antenna trimmer setting was changed or a different antenna was attached to the receiver, stations would shift to different locations on the dial. Providing a dial calibrated in frequency would have been impossible. A 0 to 100 log dial was provided and this had limited usefulness. In the GlobeSpan, the location of a given station on the dial will remain the same regardless of antenna characteristics. The GlobeSpan dial can be calibrated in frequency, if desired.

3. Traditional regen receivers were general coverage and tuned 1.7 to 30 MHz with three or four plug-in coils. The GlobeSpan covers only one shortwave broadcast band (about 500 KHz) with each coil. Tuning is much easier and regeneration is stable over the shorter tuning range.

4. In the GlobeSpan, a Colpitts circuit is substituted for the tickler coil oscillator. This allows the use of simple two terminal tuning inductors. Bandswitching is accomplished with a simple one pole switch.

5. In the 1994 version of this receiver, commercial "off-the-shelf," two-terminal inductors were used. The GlobeSpan uses hand-wound powdered iron and ferrite toroidal inductors that provide more selectivity, a more uniform Q factor over the band, and a more constant regeneration setting over the band.

6. Regeneration is controlled by changing the transconductance of a transistor. With this method, the frequency of the tuned circuit is independent of the regeneration setting. The technique of changing the transconductance of a pentode tube was known in the 1930s, but it was rarely used in regenerative receivers.

7. Most traditional regen receivers had no independent volume control. Output level was controlled by the regeneration control which also affected the receiver bandwidth. In the GlobeSpan receiver, regeneration and volume are controlled by separate potentiometers.

8. The GlobeSpan has an output for a frequency counter so that digital readout of frequency is possible.

9. The GlobeSpan input impedance to the antenna is high. A short antenna will function like an active antenna.

10. Traditional regen receivers had no RF gain control. The RF gain of the wideband amplifier of the GlobeSpan is switchable between 40 dB, 60 dB, and 80 dB.

11. All GlobeSpan controls including main tuning, are DC operated. The bandswitch is located on the circuit board. All signals stay on the circuit board from the antenna input to the speaker wire.

Space Spanner, etc.). The physical appearance of the radio is shown in the photos of Figures 2, 3, and 4.

Tuning and Performance

The regenerative radio is tuned by means of a single L-C circuit. Positive feedback (regeneration) is used to raise the quality factor (Q) of the L-C circuit to a value of 1,000 or more. This greatly increases the gain and narrows the bandwidth of the receiver.

The shape factor of the tuned circuit cannot be controlled as in the intermediate frequency (IF) stage of a superhet. Thus, it can be difficult with a regen to receive a medium level signal that is close in frequency to a very strong signal. A variable attenuator on the antenna can help with this situation. The GlobeSpan receiver does nicely in separating equally strong signals that are only 5 KHz apart.

Since the regen does not use frequency conversion, it cannot have the image frequencies characteristic of superhets. As the regen circuit is more sensitive to weak stations than to strong stations, it has an inherent function somewhat like the automatic gain control (AGC) built into most superhets. Using a four-inch speaker, the GlobeSpan provides a surprisingly good audio.

Circuit Description

The block diagram of the GlobeSpan receiver is shown in Figure 5. The schematic diagram is shown in Figure 6. A regenerative receiver can be constructed using a single transistor. The extra transistors and ICs allow for speaker operation and for other improvements in performance.

The input is an antenna buffer that presents a high impedance to the antenna and results in a short wire acting like an active antenna.

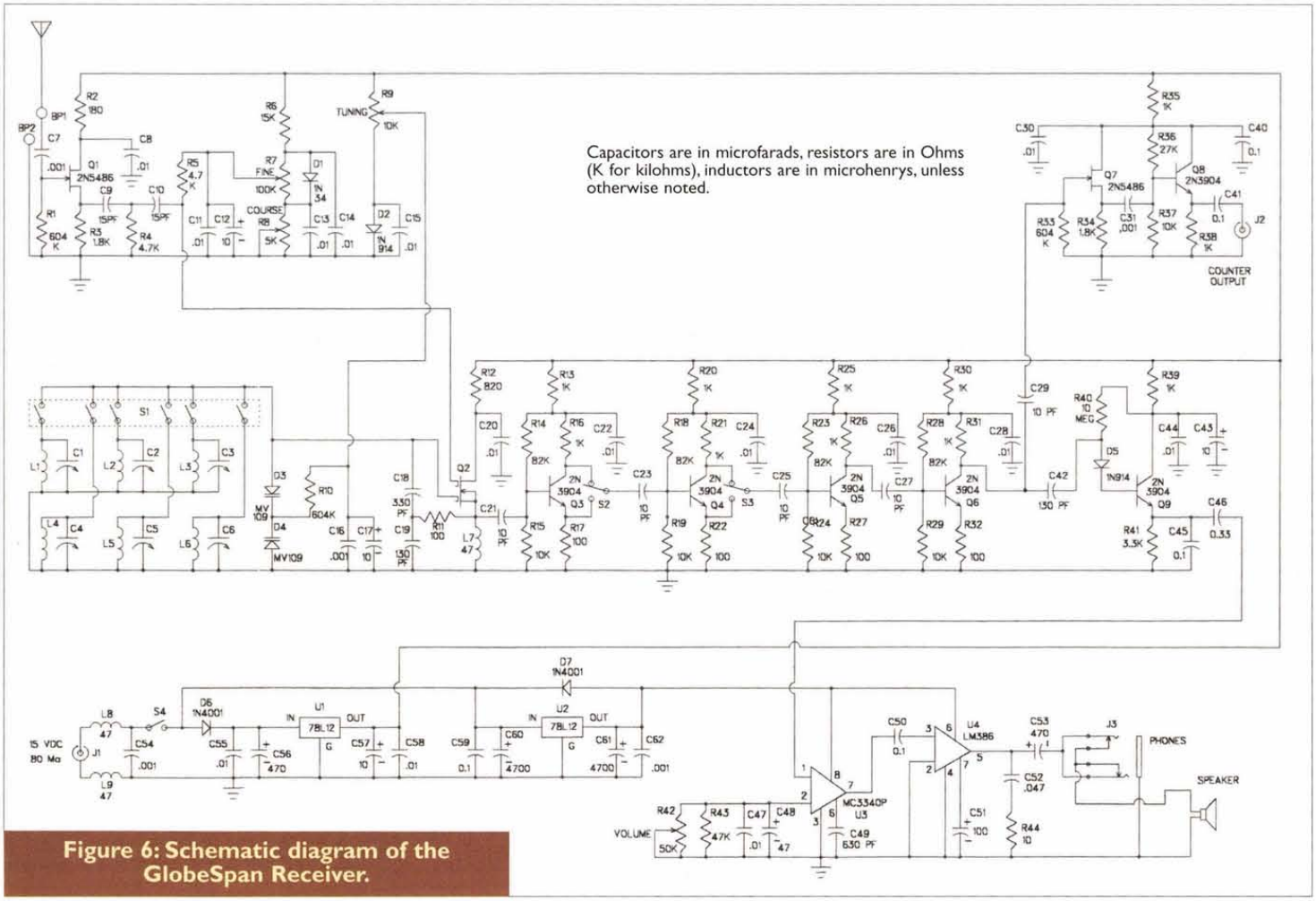

Figure 6: Schematic diagram of the GlobeSpan Receiver.

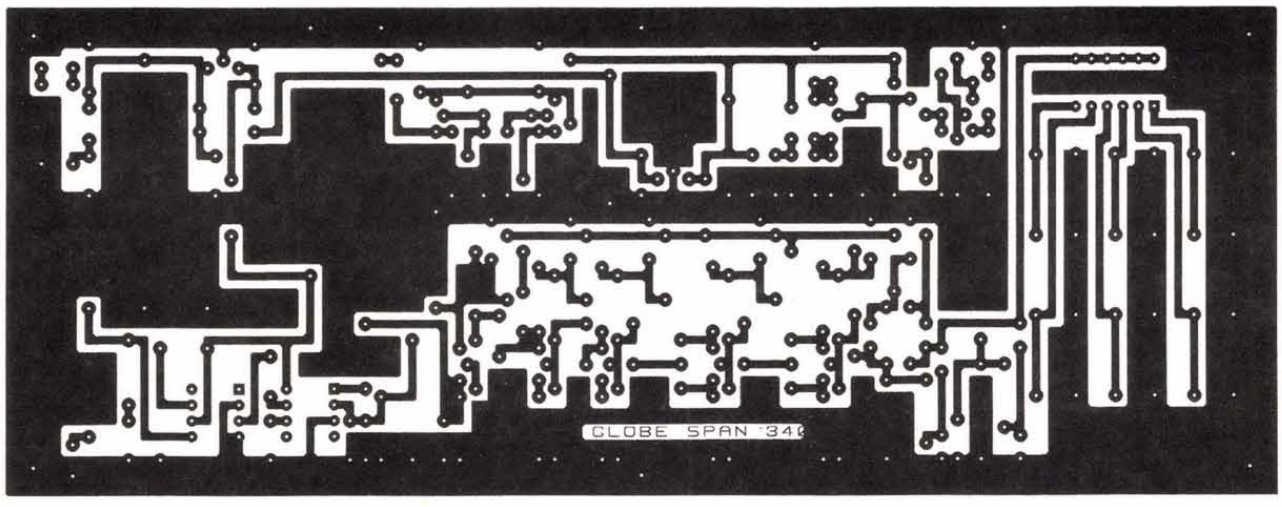

Figure 7: Printed Circuit Board Layout.

Following the antenna buffer is a high pass filter that attenuates medium wave stations and prevents overload by them. The signal then goes into gate 2 of transistor Q2. Thus, the antenna is doubly isolated from the tuned circuit.

The regenerative amplifier (Q2) tunes in the desired shortwave station. The traditional circuit shown in Figure 1 was originally called a "tickler coil oscillator" and later called a "tuned grid oscillator." A Colpitts oscillator was used in the GlobeSpan because it employs simpler inductors. Varactor diodes and a potentiometer were used for main tuning instead of a variable capacitor because mechanical variable capacitors are becoming expensive and difficult to find.

A secondary benefit of varactor and variable resistor control is that radio frequency (RF) currents are kept on the circuit board. The frequency controlling potentiometer carries only direct current (DC). A log potentiometer was used for the tuning control to compensate for the exponential characteristic of the varactors. The regeneration controls affect the gain and bandwidth of the amplifier. The course control is set so that regeneration occurs near the middle of the fine control's range. For AM stations, the control is set just below the oscillation point of the amplifier. The shortwave band is changed by switching between single

two terminal inductors. The output of the regenerative amplifier stage is radio frequency (RF).

The output of the regenerative amplifier stage (Q2) is followed by four single transistor wide bandwidth RF amplifiers (Q3-Q6). By switching two of these amplifiers for either unity gain or 20 dB gain, the total gain can be changed from 40 dB to 60 dB to 80 dB; 60 dB is the most commonly used gain selection. The simple four transistor amplifier was much more stable than several variable gain IC amplifiers that were tried.

A frequency counter buffer and the AM detector follows the wide bandwidth amplifiers. A frequency counter allows for precise measurement of the received signal or of the frequency of oscillation of the regenerative amplifier stage. This is useful for making a frequency dial for the receiver and for setting the frequency limits of the shortwave bands by use of the trimmer capacitors C1-C6.

The AM detector is based on the infinite impedance design and it presents a fairly high input impedance to the final RF amplifier. The output impedance is low enough to drive the electronic volume control that follows. A silicon diode can be used in this circuit instead of the usual germanium diode which is becoming hard to find. The input source does not have to be referenced to ground as with other diode detectors. Otherwise, the performance of this detector is the same as other single diode types.

The electronic volume control keeps the audio signal on the circuit board. This enhances the stability of the receiver. The voltage across the volume control potentiometer is direct current.

The LM386 power amplifier IC is widely available. This IC is about 25 years old and it has been used on spacecraft. Although it is a class B power amplifier, it is capable of high-quality audio within its 300 milliwatt power range. A miniature headphone jack disconnects the speaker when phones are plugged in and allows mono sound to be heard on stereo headphones.

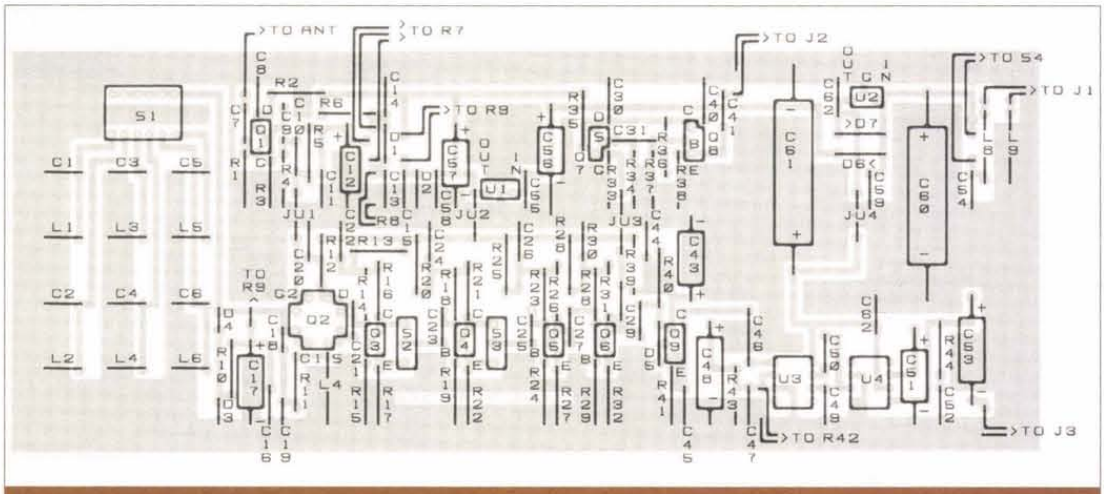

Figure 8: Printed Circuit Board Parts Placement Diagram.

TABLE 2

Toroidal Winding Instructions for Inductors L1 through L6 for the 13 International Bands and for Chokes L7 through L9.

Band	Official Frequencies	Approx. Induct.	Approximate Toroidal Winding Instructions
120M	2.3-2.495 MHz	36 µH	86 Turns of No. 32 Wire on a T-50-2 Core, or 23 Turns of No. 22 Wire on a FT-50-61 Core
90M	3.2-3.4 MHz	19 µH	62 Turns of No. 28 Wire on a T-50-2 Core, or 17 Turns of No. 20 Wire on a FT-50-61 Core
75M	3.9-4 MHz	13 µH	52 Turns of No. 28 Wire on a T-50-2 Core, or 14 Turns of No. 18 Wire on a FT-50-61 Core
60M	4.75-5.06 MHz	8.6 µH	41 Turns of No. 26 Wire on a T-50-2 Core
49M	5.95-6.2 MHz	5.6 µH	32 Turns of No. 26 Wire on a T-50-2 Core
41M	7.1-7.3 MHz	3.9 µH	26 Turns of No. 24 Wire on a T-50-2 Core
31M	9.5-9.9 MHz	2.2 µH	21 Turns of No. 22 Wire on a T-50-6 Core
25M	11.65-12.05 MHz	1.5 µH	16 Turns of No. 20 Wire on a T-50-6 Core
21M	13.6-13.8 MHz	1.0 µH	14 Turns of No. 18 Wire on a T-50-6 Core
19M	15.1-15.6 MHz	0.82 µH	13 Turns of No. 18 Wire on a T-50-6 Core
16M	17.55-17.9 MHz	0.56 µH	10 Turns of No. 18 Wire on a T-50-6 Core
13M	21.45-21.85 MHz	0.33 µH	9 Turns of No. 18 Wire on a T-50-6 Core
11M	25.67-26.1 MHz	0.18 µH	7 Turns of No. 18 Wire on a T-50-6 Core
L7, L8 & L9	RF Choke	47 µH	29 Turns of No. 22 Wire on a FT-50-61 Core

Construction

The printed circuit board layout is shown in Figure 7 and the parts placement diagram is shown in Figure 8. If a printed circuit board is used, construction is straightforward. Watch the polarity of diodes and electrolytic capacitors when inserting them into the board. A prototype of the receiver was built on vector board and that version works well. A front panel mounted rotary bandswitch can be substituted for the board mounted dip switch, if desired. More than six bands can be received if some of the inductors are mounted off the board and a switch with more poles is used.

The winding instructions for the toroidal inductors for all the shortwave bands are given in Table 2 and can each be wound in a few minutes. Six of the inductors have to be chosen for the six bands desired. The author chose the coils for 49, 41, 31, 25, 17, and 15 meters. Coils could be designed for the amateur bands or other parts of the shortwave spectrum. Although the radio draws only about 70 mA current from the power supply, using a small DC adapter has resulted in instability. An adapter capable of 500 mA of current is preferable.

The circuit board was mounted on a wooden base. The front panel design is shown in Figure 9. Figures 9 and 10 and can be downloaded from the *Nuts & Volts* web page at **www.nutsvolts.com**. The file names are GlobePanel.bmp and LogDial.bmp. The files are in bitmap format that is readable by most drawing and word processing programs and the Windows accessory programs Wordpad and Paint. Figure 9 was printed full size on legal paper and the paper was laminated. The laminated paper was then glued to particle board and the excess paper was trimed. Holes for the controls were drilled. Poster board edging was placed around the edges of the particle board and laminated paper panel.

An accurate frequency dial can be obtained by tuning the radio to various frequencies and marking the positions on the dial. An RF generator and frequency counter or a marker generator can be used as the signal source.

A log dial that is calibrated in 0 to 100 is the traditional dial for regenerative radios and is not a bad alternative to making a six-section calibrated dial. The word "log" does not mean logarithmic, but refers to providing numbers between 0 and 100 that can be used to "log" station positions in a "log" book. A log dial intended for variable capacitors and one for potentiometers is shown in Figure 10. Since each bandswitch position covers only one international band, one will have a general idea of frequency being received. The position can be logged in order that the same frequency can be found in the future. A third alternative is to use the dial from Figure 9. This dial is attractive, but will not be highly accurate due to variation in varactors, poten-

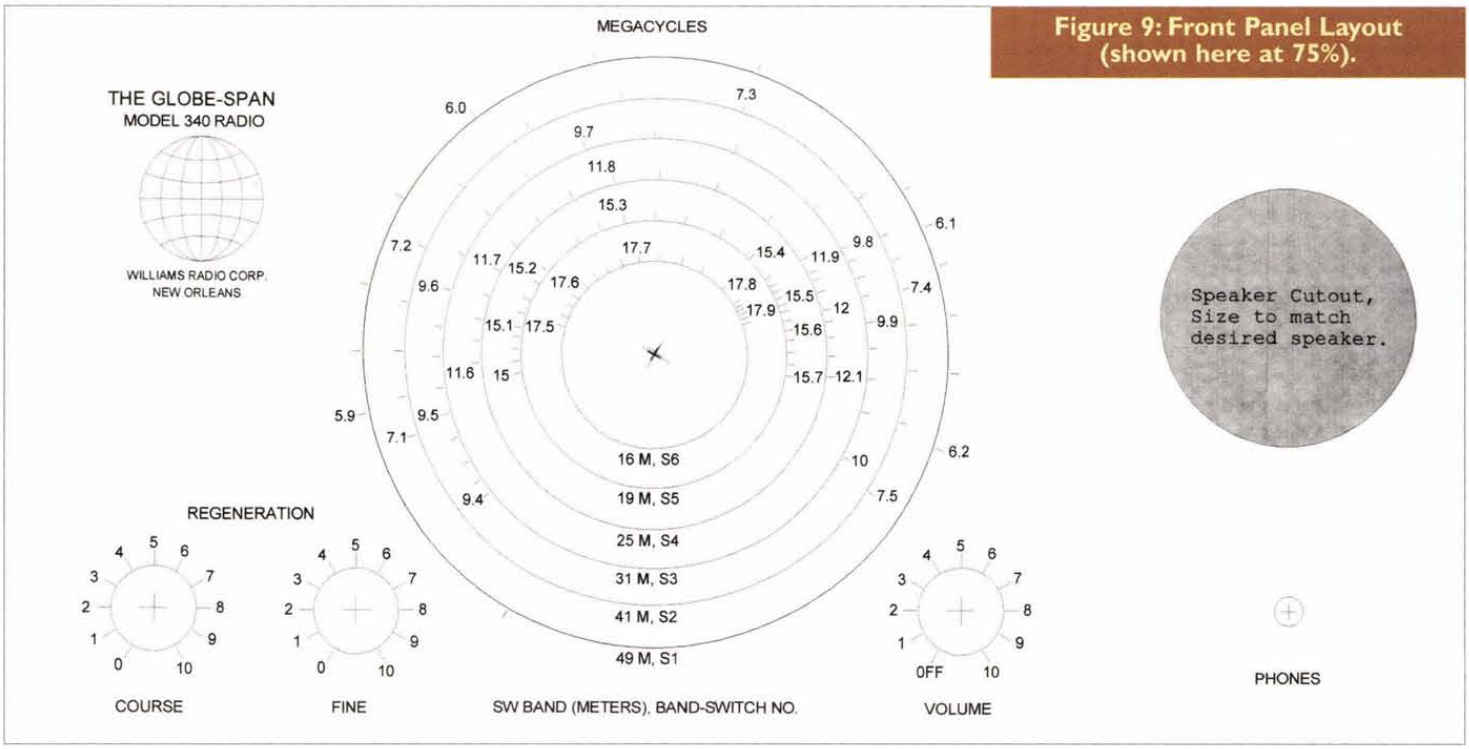

Figure 9: Front Panel Layout (shown here at 75%).

PARTS LIST

SEMICONDUCTORS

D1 — MBD101 hot carrier or 1N34 germanium diode
D2, D5 — 1N914 silicon signal diode
D3, D4 — MV2109 varactor diode
D6, D7 — 1N4001 one-amp silicon diode
Q1, Q7 — 2N5486 junction FET (MPF102 will work)
Q2 — Dual gate MOSFET: MPF121, MPF131, NTE222, or 40673
Q3, Q4, Q5, Q6, Q8, Q9 — 2N3904 general-purpose NPN silicon transistor
U1, U2 — 78L12 voltage regulator, 12 volt
U3 — MC3340P electronic volume control
U4 — LM386 audio power amplifier

RESISTORS: 1/4 watt, 5%, carbon, unless otherwise specified.

R1, R10, R33 — 604,000 ohms, metal film
R2 — 180 ohm
R3, R34 — 1,800 ohm, metal film
R4, R5 — 4,700 ohm, metal film
R6 — 15,000 ohm
R7 — 100,000-ohm panel mounted linear potentiometer
R8 — 5,000-ohm panel mounted linear potentiometer
R9 — 10,000-ohm panel mounted audio potentiometer
R11, R17, R22, R27, R32 — 100 ohm, metal film
R12 — 820 ohm
R13, R20, R25, R30, R35, R39 — 1,000 ohm
R14, R18, R23, R28 — 82,000 ohm
R15, R19, R24, R29, R37 — 10,000 ohm
R16, R21, R26, R31, R38 — 1,000 ohm, metal film
R36 — 27,000 ohm
R40 — 10 megohm
R41 — 3,300 ohm
R42, S4 — 50,000-ohm panel mounted linear potentiometer with switch
R43 — 47,000 ohm
R44 — 10 ohm

CAPACITORS: 50-volt general-purpose ceramic except where otherwise specified.

C1-C6 — 3.5-20 pF miniature ceramic trimmer
C7, C16, C31, C54, C62 — .001 µF
C8, C11, C13-C15, C20, C22, C24, C26, C28, C30, C44, C55, C58, C47 — .01 µF
C9, C10 — 15 pF silver mica
C12, C17, C43, C57 — 10 µF, 16 volt, electrolytic
C18 — 330 pF silver mica
C19, C42 — 130 pF silver mica
C21, C23, C25, C27, C29 — 10 pF silver mica
C32-C39 — These numbers are not used.
C40, C41, C45, C50, C59 — 0.1 µF
C46 — 0.33 µF polystyrene or Mylar
C48 — 47 µF, 16 volt, electrolytic
C49 — 630 pF
C51 — 100 µF, 16 volt, electrolytic
C52 — 0.047 µF
C53, C56 — 470 µF, 16 volt, electrolytic
C60, C61 — 4,700 µF, 16 volt electrolytic

INDUCTORS

L1-L6 — INDUCTORS that are selected by the builder for the six shortwave bands desired. See Table 2 for winding instructions. Cores depend on the bands chosen. The author used four T-50-6 and two T-50-2 cores.
L7-L9 — 47 µH, self resonate frequency (SRF) greater than 26 MHz (J. W. Miller 9250-473). To hand-wind these inductors, see instructions in Table 2. Three FT-50-61 cores will be required.

MISCELLANEOUS

J1 — 2.1 mm DC power jack (RadioShack 274-1565)
J2 — BNC female chassis mount connector, or other connector suitable for your counter cable.
J3 — 1/8 inch panel mount closed circuit stereo jack (RadioShack 274-246)
BP1, BP2 — Binding post or clips for antenna and ground connection
S1 — Six-pole dip switch
S2, S3 — SPDT miniature slide switch, PC board mountable (RadioShack 275-409)
SPKR — Three-inch speaker RadioShack 40-252, or as desired.
ANT — 30-inch whip antenna Radioshack 270-1401
DC Power Adapter — 15 volts at 500 mA (most unregulated supplies rated at 12 volts actually supply 15 volts and will work). RadioShack RU 11327822.
Miscellaneous — Printed circuit supplies, 6" x 12" x 3/4" wooden base, 7" x 13" x 1/8" particle board front panel, knobs, pointers, bumpers, magnet wire, hook-up wire, and solder.

The following is available from:

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tiometers, and tuning coils.

Calibration and Operation

The only alignment necessary is adjusting capacitors C1 through C6 so that the radio tunes between the desired frequency limits on each band. The capacitors should have enough range, but if not, a turn can be added or removed from the appropriate toroidal inductor to provide further frequency adjustment. The freedom from tedious calibration procedures is an advantage of this radio over superhet designs. If the Figure 9 tuning dial is being used, C1-C6 can be tuned so that one point near the center of the dial has the correct frequency. The rest of the dial will then indicate approximate frequencies.

A few feet of indoor wire is usually sufficient for an antenna. For many conditions, a short metal whip antenna attached to the wooden base will suffice. An outdoor active antenna is a nice accessory.

The tuning procedure involves setting the regeneration control until the circuit oscillates. When the receiver goes into oscillation, a "thump" will be heard from the speaker. While oscillating, a rushing sound will be heard and when AM stations are passed, a whistle (heterodyne) is heard. The regen control is then backed off until the receiver just stops oscillating. This is the most sensitive setting for the receiver for AM reception. A station is tuned in with the main tuning control and the regeneration control is readjusted for the best performance.

For SSB and code, the regeneration control is adjusted until the receiver is just into oscillation. The receiver then acts as if it had a beat frequency oscillator (BFO) attached. Careful adjustment of the main tuning control and the regeneration control will result in the SSB signal being understandable or the code signal having a pleasant tone.

Although the author owns a number of shortwave receivers from an ancient Collins collossus to a couple of modern Sony digitally-controlled receivers, the GlobeSpan is frequently used. The overall performance of the GlobeSpan falls somewhere between that of a simple superhet and a communications receiver. Considering the simplicity of the regen design, such performance is remarkable. **NV**

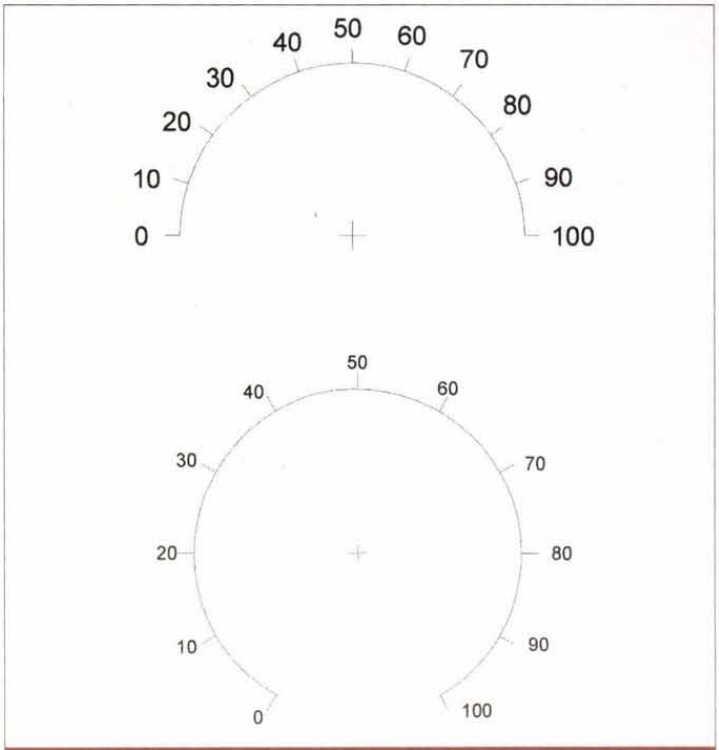

Figure 10. A "log" dial provides reference numbers for a received station that can be recorded in a log book so that the station can be located in the future. The two examples here are suitable for variable capacitor tuning (top) and for variable resistor (voltage) tuning (bottom).

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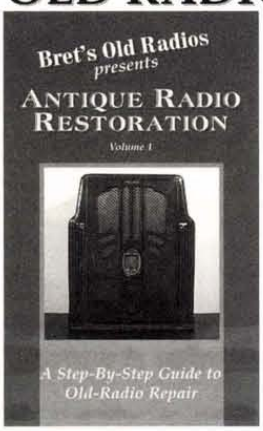

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-Steve Billings, editor
Puget Sound Antique Radio Assoc. Newsletter, June 2001

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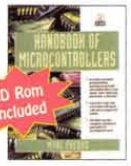

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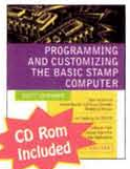

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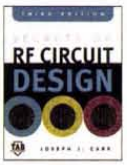

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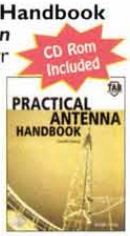

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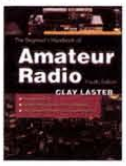

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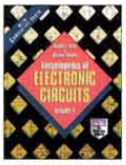

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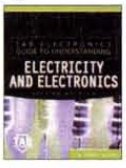

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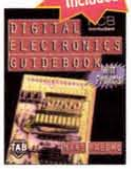

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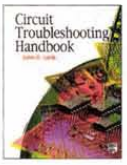

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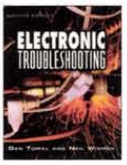

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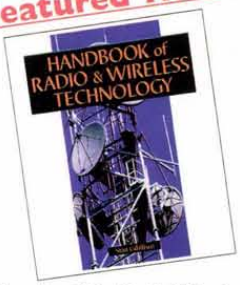

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JUNE 2

IL - PRINCETON - Hamfest. Starved Rock RC, 815-433-2117. Email: bk9vzh_gov@yahoo.com
PA - PITTSBURGH (BUTLER) - Hamfest. Breezeshooters ARC, 412-221-3806. Email: n3ue@arrl.net Web: http://www.breezeshooters.net
VA - MANASSAS - Hamfest. Ole Virginia Hams ARC, 703-335-9139. Email: n4yic@arrl.net Web: http://www.qsl.net/olevahams

JUNE 7-8

MS - PASCAGOULA - Hamfest. Jackson County Fairgrounds Civic Center. Jackson County ARC, 228-826-5095. Email: nn5af@arr.net Web: www.angelfire.com/ms3/jcarc

JUNE 8

MO - MACON - Hamfest. Macon County, Nemo, Schuyler, & Tri-County ARCs, 660-385-3629. Email: n0pr@arrl.net Web: www.qsl.net/n0pr/hamfest.html
PA - BLOOMSBURG - Convention. Columbia Montour ARC, 570-784-2299. Email: n3kyz@jlink.net Web: http://www.qsl.net/cm-arc
TN - KNOXVILLE - Hamfest. Cokesbury Center, 9915 Kingston Pike. Knoxville RAC, 865-670-1503. Email: d.bower@ieee.org Web: www.w4bbb.org

JUNE 9

IL - EFFINGHAM - Hamfest. National Trail ARC, 217-342-3054 (M-F 9am-5pm).
IL - GRANITE - Hamfest. Southwestern IL College Campus, IL Rt. 203. The Egyptian RC, 618-655-1232, email: w9pat@arrl.net. 618-667-4592, email: kb9ail@arrl.net. 618-656-0905, email: k2kfw@arrl.net Web: www.w9aiu.org
IL - WHEATON - Hamfest. Six Meter Club of Chicago, 708-442-4961. Email: wa9fih@arrl.net http://cyberconnect.com/orion/hamfest.htm
KY - INDEPENDENCE - Hamfest. Northern Kentucky ARC, 513-797-7252. Email: n8jmv@arrl.net

JUNE 14-15

NE - SOUTH SIOUX CITY - Convention. 3900 Club, 712-252-4107 (10am-5:30pm). Email: tands@pionet.net Web: http://www.3900club.com

JUNE 15

NJ - DUNELLEN - Hamfest. Columbia Park. Raritan Valley RC, Inc., 732-469-9009, email: wb2njh@aol.com, or 732-968-7789
OH - MILFORD - Hamfest. Milford ARC, 513-753-5066. Email: kb8snh@cs.com

JUNE 16

IN - CROWN POINT - Hamfest. Lake County Fairgrounds. Lake County ARC, PO Box 90, Crown Point, IN 46308
MA - CAMBRIDGE - Hamfest. MIT Radio Society/Harvard Wireless Club/MIT UHF Repeater Assn., email: w1gsl@mit.edu (617-253-3776 9am-5pm.) Web: http://web.mit.edu/w1mx/www/swapfest.html
MI - MONROE - Hamfest. County Fairgrounds. Monroe County Radio Communications, Assn., 734-242-9487 after 5pm. Email: ka8ebi@arrl.net Web: mcrca.org/hamfest.htm

JUNE 28-29-30

CA - FERNDALE - Convention. Humboldt ARC, Redwood ARC, Farwest Repeater Assn., & Southern Humboldt ARC, 707-442-3866. Email: conven@humboldt-arc.org Web: www.humboldt-arc.org

JUNE 30

NY - QUEENS - Hamfest. NY Hall of Science parking lot, Flushing Meadow Corona Park, 47-01 111th St. The Hall of Science Amateur Radio Club, 718-898-5599. Email: WB2KDG@Bigfoot.com

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Events Calendar

July 2002

JULY 4

PA - HARRISBURG (BRESSLER) - Hamfest. Harrisburg RAC, 717-938-8249. Email: k3pd@arrl.net Web: http://hrac.tripod.com/July4.htm

JULY 6

WI - OAK CREEK - Hamfest. American Legion Post 434, 9327 S. Shepard Ave. South Milwaukee ARC, Inc., 414-762-3235, email: ryatex@aol.com

JULY 7

IL - PEOTONE - Hamfest. Kankakee Area Radio Society, 815-933-1323. Email: karsfest@yahoo.com Web: www.w9az.com
PA - WILKES-BARRE - Hamfest. Murgas ARC, 570-824-7579. Email: n3wpg@juno.com Web: http://www.qsl.net/k3ytl

JULY 12-13-14

UT - BRYCE - Convention. Utah Hamfest Committee, 801-547-9218. Email: jimkatpa@aol.com Web: www.utahhamfest.org

JULY 13

GA - GAINESVILLE - Hamfest. Lanierland ARC, 770-967-6364. Email: w4tl@arrl.net Web: www.lanierlandarc.org/hamfest.htm
TN - CLEVELAND - Hamfest. Cleveland ARC, 423-472-1660. Email: bgault@wingnet.net

JULY 14

PA - KIMBERTON - Hamfest. Mid-Atlantic ARC, 610-667-1650. Email: sflink@juno.com Web: www.marc-radio.org/hamfest.html
PA - PITTSBURGH (NORTH HILLS) - Hamfest. Northland Public Library. North Hills ARC, 412-486-1681. Email: aa3ta@bellatlantic.net Web: www.nharc.pgh.pa.us

JULY 19-20

OK - OKLAHOMA CITY - Oklahoma State Fair Park, Oklahoma Bldg., intersection I-40 & I-44. Central Oklahoma Radio Amateurs, Inc., www.geocities.com/heartland/7332

JULY 20

NC - CARY - Hamfest. Cary Community Center. Cary ARC, email: n4nc@arrl.net
NY - ALEXANDER - Hamfest. Genesee Radio Amateurs, 716-343-2844. Email: wa2abq@localnet.com

JULY 21

IL - SUGAR GROVE - Hamfest. Fox River Radio League, 815-786-2860. Email: w9ceo@arrl.net Web: www.frrl.org/
MA - CAMBRIDGE - Hamfest. MIT Radio Society/Harvard Wireless Club/MIT UHF Repeater Assn., email: w1gsl@mit.edu (617-253-3776 9am-5pm.) Web: http://web.mit.edu/w1mx/www/swapfest.html
MO - WASHINGTON - Hamfest. Zero Beaters ARC, 636-629-7368 (days) Email: n0mfd@arrl.net

JULY 26-27

FL - MILTON - Hamfest. Santa Rosa County Auditorium. Milton ARC, 850-994-7335. Email:

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JULY 26-27-28

AZ - FLAGSTAFF - Convention. Amateur Radio Council of AZ, 602-881-2722. Web: www.arca-az.org/arca

JULY 27

NC - WAYNESVILLE - Hamfest. Western Carolina ARS, 828-236-0181. Email: wa4ola@arrl.net http://wcars.org/hamfest/index.htm
NY - FRANKFORT - Hamfest. Utica ARC, 315-797-6614. Email: ktrnd@borg.com
OH - CINCINNATI - Hamfest. Diamond Oaks Career Development Campus, 6375 Harrison Ave. OH-KY-IN ARS, 859-657-6161. Email: wd8jaw@arrl.net Web: http://www.ohkyin.org

JULY 28

CA - SANTA ANA - ACP Computer Show & Swapmeet. Giant ACP Parking Lot. 714-558-8813. Email: jferguson@acpsuperstore.com Web: www.acpsuperstore.com
MD - TIMONIUM - Hamfest. BRATS, 410-828-1605. Email: bbennett@ketron.com Web: www.bratsatv.org

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AUGUST 3

NY - ITHACA - Hamfest. Tompkins County ARC, 607-257-6066. Email: jdreid@lightlink.com Web: www2.compcenter.com/~tcarc/
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AUGUST 3-4

KY - LEXINGTON - Convention. National Guard Armory. Bluegrass ARS, Inc., 859-253-1178. Email: jrbarnes@iglou.com

AUGUST 4

NY - WILLIAMSVILLE - Convention. Lancaster ARC, 716-683-8880. Email: luke@town-countryflorist.com Web: http://hamgate1.sunyerie.edu/~larc

AUGUST 10

IL - QUINCY - Hamfest. Western IL ARC, 217-222-4467. Email: w9awe@arrl.net Web: www.qsl.net/w9awe
WI - BARABOO - Circus City Swapfest. Sauk County Fairgrounds, Hwy. 33. Yellow Thunder ARC, Inc., 608-356-2313, email n9udo@arrl.net or 608-643-6908 days, 608-643-6453 eves. Web: www.qsl.net/ytarc/hamfest.htm

AUGUST 11

IL - PEOTONE - Hamfest. Hamfesters Radio Club, 708-756-7984. Email: wb9wfr@arrl.net Web: www.hamfesters.org
IN - GREENTOWN - Hamfest. Kokomo & Grant County ARCs, 765-668-4814. Email: k9nqw@arrl.net Web: www.grantarc.com/greentown.html

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Learning RVK-Basic Part 6

By Bob Vun Kannon

RVK-Basic is a free Basic compiler for the Atmel AVR line of microcontrollers. You can download a copy of this compiler from the Nuts & Volts web site (www.nutsvolts.com). With this compiler, you can write and compile very fast, efficient programs for most of the AVR microcontrollers.

In this article, we will continue the subject of program structure and take a good look at loops.

The DO Loop

The DO loop is a simple method of repeating code forever, or until you make it exit from the loop. A good example of this kind of usage can be found in the Xylon program supplied with the compiler and reproduced hereafter.

```
DEVICE 2313
    MHZ   4
    REVISION XYLON_010313.0-rvk

    '..A DEMO PROGRAM TO PRODUCE MOVING LIGHTS..
    '..ON AN STK200 BOARD.....

    DIRPORT B,OUT

    EEDATA  BEGIN:,6
    EEDATA  ,&B01111110
    EEDATA  ,&B10111101
    EEDATA  ,&B11011011
    EEDATA  ,&B11100111
    EEDATA  ,&B11011011
    EEDATA  ,&B10111101

    READ max,BEGIN:,0       '...read number of data values

    DO                      '...do forever...
     FOR i = 1 TO max       '...pattern length is max...
      READ temp,BEGIN:,i
      OUTPORT B,temp        '...write value to the port
      PAUSE 100             '...time kill 100 mseconds....
     NEXT
    LOOP
```

This program causes lights to move in and out in a manner reminiscent of the moving light display on the fiendish robots of the old Battlestar Galactica space opera. Note that the DO and LOOP statements cause the program to repeat endlessly over and over.

The only way out of a DO/LOOP is to insert an EXIT DO statement inside the loop. When encountered, such a statement will transfer program flow to the statement after the next LOOP statement.

The FOR NEXT Loop

Just inside the DO/LOOP of the Xylon program, there is a FOR/NEXT loop. This type of loop uses a variable as a counting number and counts (in increments of 1) until the loop variable equals the value following the TO keyword. In the case in point, the variable i will be 1 on the first time through the loop and will increment by one each successive time through until it reaches the NEXT statement with a value equal to the variable max. At that point, the program will then reach the LOOP statement.

The variable used as the loop variable may be either an integer or a byte. A byte, particularly a register byte, will execute more quickly and generate fewer words of code.

The reader should note well that the FOR/NEXT loop in RVK-Basic will always execute the contents of its loop at least one time because the test for exiting the loop is at the bottom of the loop in the NEXT statement. This is different from other forms of Basic (like Quickbasic and Power Basic) where the test is made at the top of the loop. Also take careful note of the fact that the loop will exit only when there is an exact match between the loop variable and the final value. (In other Basics, the loop will also terminate when the loop variable exceeds the final value.)

It is also possible to exit the FOR/NEXT loop by executing an EXIT FOR statement inside the loop. Whenever this happens, program flow will resume at the statement following the next NEXT statement.

So in our example of code above, the FOR loop will execute max times, beginning with i set to 1. Since max was set to 6 by the READ statement just above the loops, this FOR loop will execute six times.

Because the value of i is known to increment from 1 to 6 in this loop, the program can use the i variable as an index to point to successive bytes in EEPROM. On the first pass through the loop, the READ statement inside the loop will get the first value after the BEGIN: location. So the first time through, the temp variable will become &B01111110, which means that the B,0 and B,7 LEDs will be turned on. The next pass, when i = 2, will read &B10111101 and turn on the B,1 and B,6 LEDs.

In general, the FOR/NEXT loop is very useful for counting repetitions. You've also seen that a READ statement can be used to retrieve a byte from EEPROM and that the EEDATA statement will place data in the EEPROM. Look up the STORE statement in RB.TXT to learn how to write to the EEPROM under program control. EEPROM is a great place to store tables and constants and can be used to store data that changes very seldom.

The WHILE WEND Loop

The WHILE/WEND loop is a loop with a built-in test at the top of the loop. This loop will continue repeating itself until the test condition fails. There is also an EXIT WHILE statement that may be used inside the loop to exit.

Let's use a WHILE/WEND loop to cause a program to hold up until D,0 goes high. We could do this with the following code:

```
INBIT temp,D,0
WHILE temp = 0
        INBIT temp,D,0
WEND
```

The first statement reads the LSB (Least Significant Bit) of D into the variable temp. The While loop will then continue to loop until temp becomes non-zero (D,0 goes high).

In all fairness to the ubiquitous DO loop, we could have accomplished the same thing with the following code:

```
DO
        INBIT temp,D,0
        IF temp | 0  THEN
                EXIT DO
        END IF
LOOP
```

So now that we have two ways of doing the job, which is better? The first version used four lines of RVK-Basic and the second took up six lines of RVK-Basic. Does that mean the first is tighter than the second?

Looking at the Assembler

The good programmer will not be afraid to use all the tools available to him. To answer the question posed by the two different approaches in the example above, we will make use of a peculiarity of RVK-Basic.

This compiler does not generate object code (or machine code). Instead, the RVK-Basic compiler generates assembler source code. This is text code that you can actually look at with an editor (like EDIT or Notepad). After the compiler has generated this assembler file, the assembler will generate several files which may include object code for program memory, object code for EEPROM, and a LIST file which will show you where everything is located in memory.

Take the first example of the WHILE loop above, put a DEVICE 1200 statement on the front end and save it as TEST1.BAS. Now compile it by

```
RB test1
```

Then assemble that with

```
ASM test1
```

Now open up the TEST1.LST file with an editor and pull down into it until you see the following (at the bottom of the file).

```
        ;.....................................
00000a 27ff     RST_00: CLR     r31     ;...main program begins here..
00000b b9f8             OUT     ACSR,r31;..power up anlg comp...
00000c bbf7     OUT     DDRB,r31
00000d bbf1             OUT     DDRD,r31
00000e b3f0             IN      r31,PIND        ;       INBIT temp,D,0
00000f 70f1     ANDI    r31,$1
000010 2e0f             MOV     TEMP_,r31
                        ;               ;       WHILE temp = 0
        DL001B:
000011 e0d0             LDI     r29,$0
000012 120d             CPSE    TEMP_,r29
000013 c001             RJMP    IF001E
```


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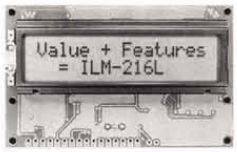

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```
000014 c001              RJMP   IF001X
000015 c004     IF001E:  RJMP   EN001

000016 b3f0     IF001X:IN       r31,PIND        ;       INBIT temp,D,0
000017 70f1            ANDI     r31,$1
000018 2e0f            MOV      TEMP_,r31
000019 cff7     DL001L:RJMP     DL001B          ;       WEND
00001a cfff     EN001: RJMP     EN001 ;         END
        .eseg
        .exit
```

This is where your code gets executed. The numbers on the left are the addresses (in hex) of the program counter. We can see that our test code begins with the first INBIT statement (isn't it nice to have your original Basic code embedded as comments?) at address 0000e and continues through the WEND statement at address 000019. That occupies 12 words of memory.

Now compile and assemble the code, which uses the DO loop and look at its LST file.

```
        ;.....................................
00000a 27ff     RST_00: CLR     r31     ;...main program begins here..
00000b b9f8             OUT     ACSR,r31;..power up anlg comp...
00000c bbf7             OUT     DDRB,r31
00000d bbf1             OUT     DDRD,r31
        DL001B:         ;       DO
00000e b3f0             IN      r31,PIND        ;       INBIT temp,D,0
00000f 70f1     ANDI    r31,$1
000010 2e0f             MOV     TEMP_,r31
000011 e0d0             LDI     r29,$0  ;       IF temp | 0  THEN
000012 160d             CP      TEMP_,r29
000013 f409             BRNE    IF002
000014 c001             RJMP    DL001L
000015 c001 IF002:      RJMP    DL001E  ;                       EXIT DO
                        ;       END IF
000016 cff7     DL001L:         RJMP    DL001B  ;       LOOP
        DL001E:
        .eseg
        .exit
```

Here we can see that the equivalent code stretches from the DO statement to the LOOP statement, or from address 0000e to 000016. That's only nine words of code, or three words of code less than doing the job with a WHILE loop.

I can hope at this point the reader of all six of these articles on Learning RVK-Basic has made great progress and is now capable of writing his own code and getting it running. But no matter how much you think you know about this language, make it a habit to look things up in the RB.TXT file as you write your code. This will not only help you to always get your syntax right the first time, but you will stumble across new statements and ideas from time to time.

Remember that the secret to getting embedded code running successfully is to test and debug very, very small portions of the code first. Then integrate the small portions together into bigger portions and debug again. Continue in this manner, testing small portions until the whole program is up and running.

Happy programming! **NV**

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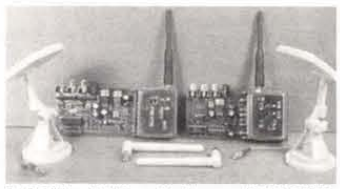

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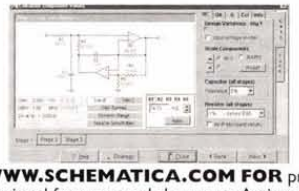

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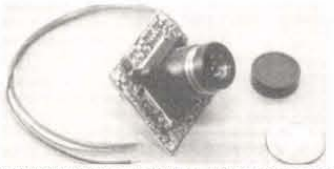

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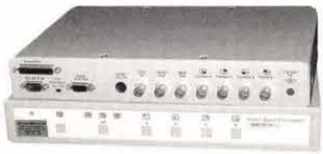

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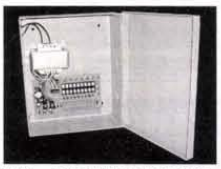

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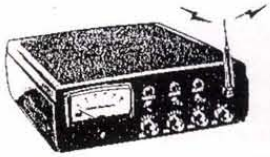

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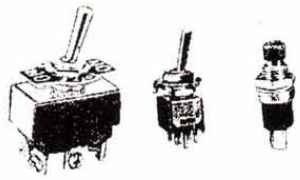

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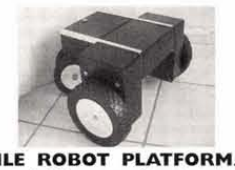

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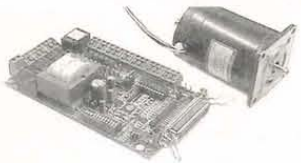

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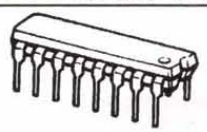

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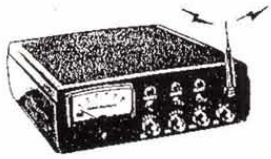

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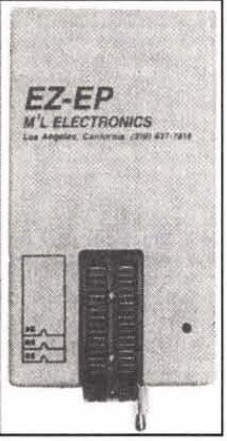

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Prepaid ads received by 5:00pm on the **closing date (1st of the month)** will appear in the following month's issue. Ads postmarked through the **1st**, but received after the closing date, will be placed in the next available issue. No cancellations or changes after the 1st. Cancellations and changes must be submitted in writing.

IMPORTANT INFORMATION

All classified ads are running copy only. No special positioning, centering, dot leaders, extra space, etc. is allowed. All advertising in *Nuts & Volts* is limited to **electronically related items ONLY**. All ads are subject to approval by the publisher. We reserve the right to reject or edit any ad submitted. We do not take ad copy or changes over the phone. We do not bill for classified ads. Repeat ads or ads run in multiple classifications within the same issue are allowed. Paid subscribers may run ads at the 60¢ rate only through their subscription expiration date. **NO REFUNDS**. Credit only. No credit for typesetting errors will be issued unless you *clearly* print or type your ad copy.

Choose a category for your ad from these classifications.

10. Ham Gear	125. Microcontrollers
20. Batteries/Chargers	130. Antique Electronics
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40. Music & Accessories	138. Thermocouple Welder
50. Computer Hardware	140. Publications
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85. Security	155. Manuals/Schematics Wanted
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110. Cable TV	180. Education
115. Telephone/Fax	190. Business Opportunities
120. Components	200. Repairs/Service

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News Bytes
Continued from Page 15

how to attract more radio hobbyists to the amateur service. Most all industry members agreed that small ads in selected magazines for RVers, flyers, mariners, and camping enthusiasts would surely bring in leads. An ongoing discussion with the Amateur Radio Relay League confirms no ad trade-out program in place, nor any marketing plan on how to follow up on a lead to their 800 number when someone wants to become a ham radio operator.

The American Association of Radio Enthusiasts (AARE) was formed as a non-profit corporation for the promotion of amateur radio and all emergency communications into different markets, and to provide a conduit for dealers and all hobby radio manufacturers to exchange ideas, work together on projects, and help the radio services grow. The amateur radio service might be double the number of hams in the next five years with an aggressive marketing program covering a wide range of age brackets, and even a wider range of "other" recreational hobbies.

"The amateur license will be much easier to obtain next year when the entry-level Technician class test is completely rewritten," adds Julian Frost N3JF, a ham radio instructor who works closely with kids.

"Out go the technical questions about the inner workings of a radio, and in will come test questions written by active ham radio operators to better

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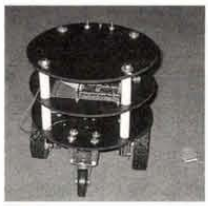

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TIME: 10:30 A.M.
Inspection: 9:00 a.m. till sale

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reflect those subjects that hams need to know to become a good entry-level operator," adds Frost, referring to an announcement by the Amateur Radio Question Pool Committee that the Technician class for July 1, 2003 (next July), will undergo a major rewrite. The ham industry will also explore the best way to handle incoming inquiries on how to become a ham.

"Right now the leads may come into an 800 number, and the recipient simply gets a single letter with a computer listing of ham clubs, test sites, and a list of ham instructors within a relatively large geographic area. There appears to be no follow up nor any local ham ambassador to work these leads, and this may be an area where industry might help," adds William Alber, a ham instructor taking advantage of industry costly promotional items like laminated world maps, large full-color frequency charge, expensive log books, free copies of magazines, and other offers from the amateur industry to help support ham instructors viewed as "representatives" in the marketing of ham radio.

Members of AARE were chosen to lead the debut this year. They represent many facets of the ham radio equipment and accessory market:

- Ray Novak KC7JPA, ICOM America, serving as President.
- Rick Ruhl W4PC, of Creative Services Software, Vice-President.
- Evelyn Garrison WS7A, representing Alinco, as Secretary/Treasurer.
- Gordon West WB6NOA, Gordon West Radio School, Advisory Board of Directors.
- Bob Heil K9EID, Heil Sound, Board of Directors.
- Randy Gawtry K0CBH, Timewave Technology, member-at-large.

The AARE website is at http://www.aaregroup.org. The group will be "the voice" of the manufacturers and dealers in radio, much like the American Radio Relay League is the voice of each ham radio operator.

"We look forward to encompassing all aspects of the amateur radio industry retail dealers, manufacturers, and distributors. This organization will provide an important focal point leading to the growth of the amateur service," said Novak.

It was pointed out in the industry meeting that only a small percentage of entry-level test preparation book buyers ultimately become licensed as a Technician class operator. Next year's complete rewrite of the Technician test question pool may substantially increase the number preparing for the test to ultimately become licensed hams. The

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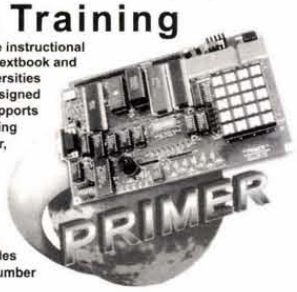

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industry group will also work together to promote new fresh Technician class test questions from all ham operators who want to see our service grow with better trained newcomers coming on the airwaves. The industry group will also develop a closer relationship with the American Radio Relay League and sort out the great debate on "Whose job is it anyway?" to develop ads and promotions to those other hobby areas that may be a "natural" for ham radio licensing.

The industry will also embrace other radio service industry members to join them to better educate the public and citizens emergency response team volunteers on the importance of ham license and no-license radio equipment, and how to use that equipment in case of a national or local emergency. With the National Weather Service soon to develop a new electronic voice over its 24-hour weather stations, there needs to be more public awareness on all of the safety benefits of a weather receiver in addition to more information about weather alert, as well as geographical S.A.M.E. specific area announcements.

Both the industry, as well as all radio users are encouraged to look at the AARE website at http://www.aare-group.org to add input to this newly formed group, or to find out how to join this group as part of the radio industry. Ham radio operators wishing to submit new entry-level Technician class questions for next year's Technician test may do so at QPC @arrl.org.

Dealers and manufacturers of amateur radio products are welcome to join AARE by contacting Evelyn Garrison at evelyn@aaregroup.org.

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by Robert Nansel

Amateur Robotics

Last month, I showed an experimental design for a linear actuator. It is cheap — all the materials, including roller switches, come to about $15.00 per actuator. However, as I noted last month, my first prototype failed after only a few seconds of operation.

It turned out my first try at machining a brass follower nut using only a drill press and hand files wasn't precise enough. The threaded section of the nut was about 1.5 degrees out of alignment with the motor shaft once the nut was mounted in the slide tube.

As long as the slide tube was mostly retracted, the ends of the threaded rod and motor shaft stayed in close alignment. On extension, though, that 1.5-degree angle caused increasing misalignment. At 11,500 RPM the silicone coupler tubing tore instantly.

This month, I set about refining my machining techniques. Anyone with a metal-cutting lathe with a four-jaw chuck could do the job in less than an hour. I don't have a lathe, though, and neither, I suppose, do most of my readers. I was determined to find ways to do the job with the tools I have.

I'm happy to report success. Though there were a few bumps along the way, I came up with simple strategies to achieve better precision — and reduce the need for it.

Quest for Precision

Last month, I identified several areas where the actuator design needs more precise machining: squaring the follower nut block; centering the hole to be drilled through the block; aligning the tap while tapping the threads; and aligning the follower nut while mounting it in the slide tube. Since I reckoned most of the 1.5-degree shaft misalignment in my prototype arose from the latter, I'll talk about that first.

The follower nut block is cut from brass bar stock, nominally 5/16", but actually about .310" square. The inside dimension of the 3/8" slide tube in which it is mounted, though, is .318", so the block could be offset at each of its ends by as much as .008". The threaded hole could thus end up offset from center, tilted, or both. When the block is .310 long, a .008" offset between the ends works out suspiciously close to the 1.5-degree misalignment mentioned above. Doubling the length of the follower nut cuts the possible misalignment angle in half, to .75 degrees, but that's still too much.

One way to reduce the worst case misalignment is to come up with a larger block. You could machine the nut from larger stock so it fits in the slide tube exactly, but that would require lots of filing, or a lathe or a milling machine if you want to do it quickly. Another way is to make the existing .310" stock larger by adding shims. I chose this route because it's simple and quick.

Small Parts sells sheets of brass shim stock ranging from .001" to .031" thickness. I chose .003" (# 1030-3, $3.07 a sheet). When wrapped around the .310" brass stock, the shim stock brings it up to .316" square. The .003" stock cuts nicely with scissors.

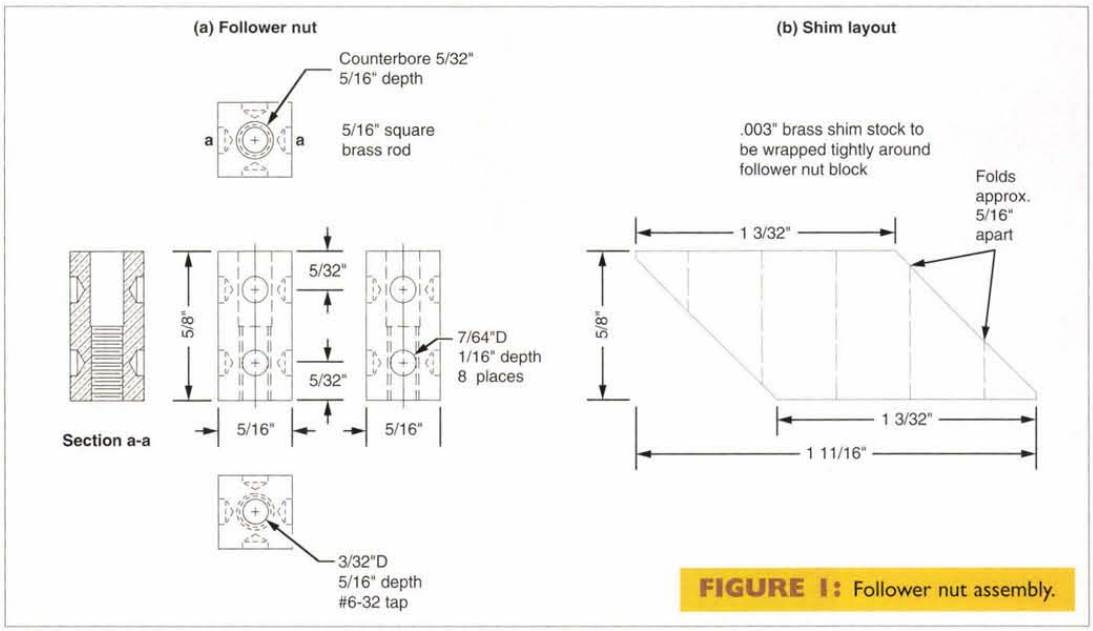


FIGURE 1: Follower nut assembly.

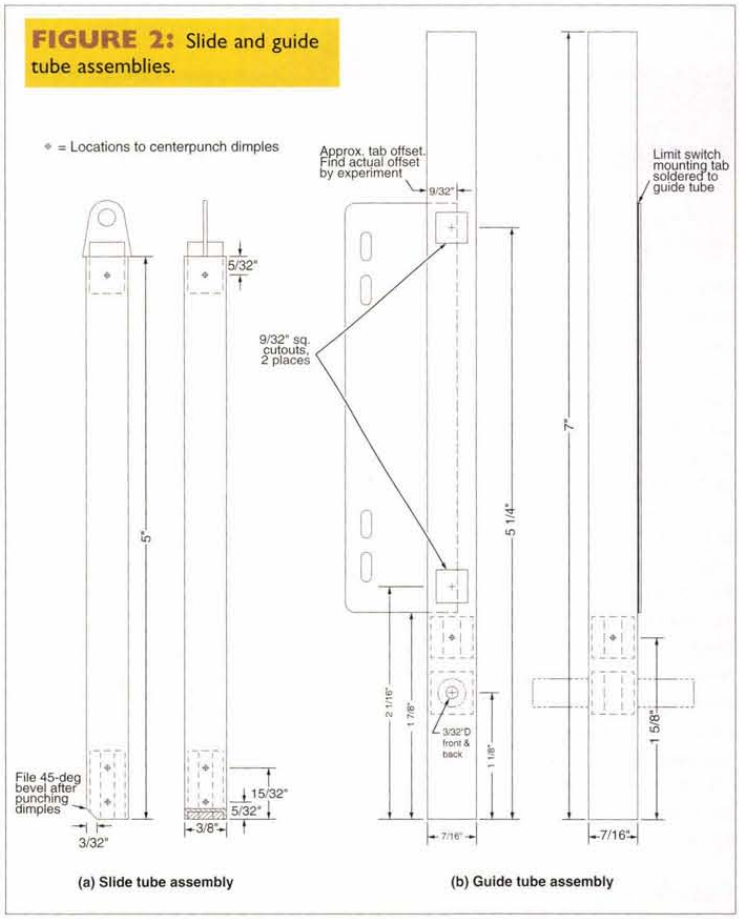


FIGURE 2: Slide and guide tube assemblies.

Figure 1 shows the redesigned follower nut and the

PHOTO 1: Clamping arrangement for drilling and tapping the follower nut. The V-block holds the block in alignment with the drill press spindle, and the wood clamps keep the V-block from moving. Adjust side-to-side and back-and-forth with light taps from a mallet handle.

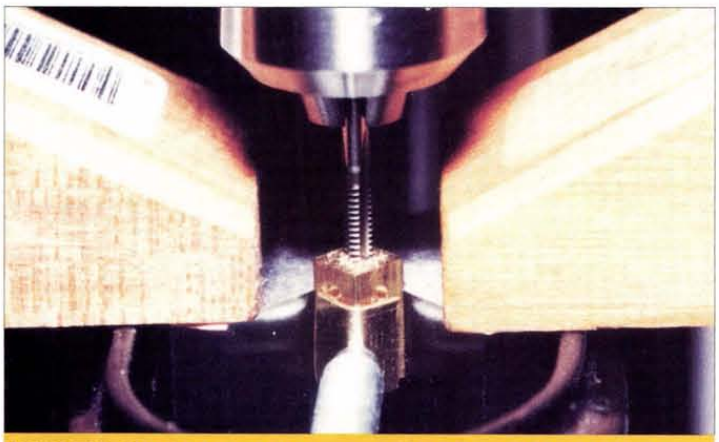


PHOTO 2: Using the drill press — unplugged — to tap the follower nut. The chuck holds the tap in proper alignment for cutting the critical first few threads. Turn the spindle pulley by hand.

shim stock layout. I've made the block twice as long as my first one, and I accordingly used eight dimple holes instead of four. The idea is the exact position of one dimple will have less of an effect on the precision when there are eight dimples rather than four.

Notice also only 5/16" of the bore is threaded to allow the threaded shaft more wiggle room. For ordinary screw threads only six threads will take 98% of the load. The last two threads are often not formed well, so you need eight threads engaged minimum to ensure full strength. Tapping with 6-32 for 5/16" gives 10 threads, two threads more than the minimum — a good safety factor.

Careful Layout

More care in laying out the various components pays big dividends in precision. It may sound simple, but one thing I did this month was use a sharper scribe. Formerly, I had been using a length of coat hanger wire with one end sharpened, but the steel was too soft to hold a sharp point, even with heat treatment (not enough carbon in the steel). Machinist scribes cost about $5.00 at my local hardware store, but I found that a large safety pin works fine. The next time I place an order with Enco or Wholesale tool, I'll get a couple of their $2.49 specials, but until then, I'll use the safety pin.

Another way I increased repeatability — and that's what precision is really about — was to use my wood worker's marking gauge to scribe centerlines on blocks and tubes. I had already been using a vernier caliper for accurate measurements, but it's not really meant for transferring dimensions to a layout. In lieu of a height gauge, the marking gauge worked fine. It sped up my layout and made it more precise.

Finally, I used a magnifier and plenty of light when setting prick-punch to mark hole locations.

Being a Blockhead

I'm pretty good with a file, but last month the small pieces for this project gave me so much trouble I began to doubt my skills. Filing to a line isn't hard with larger pieces because usually you have relatively more metal to remove, and so the file cuts slower. You get plenty of warning before overshooting the line.

With the tiny brass parts I've been working with, though, all it takes is one or two extra strokes to obliterate the scribed line, and precision goes out the window. After my third failure to make an accurately-squared block, I consulted various machining references and, finding nothing there, queried folks on the "Gingery Machines" tool-building list on Yahoo to see if there are special techniques for filing small stuff. I did get the suggestion to use a smaller file, but not much else. Back to the books.

I found the answer on pages 56 and 57 of *Elements of Machine Work* by Robert H. Smith. This book dates from 1910, and it was apparently written for blockheads like me who didn't pay close enough attention to their shop teachers when they had the chance. Like most books in my machining library, it's available through Lindsay Publications at www.lindsaybks.com. (Geez, I ought to get a commission from these guys, I plug their books so often.)

Anyhow, the secret is to first bevel the edges of the block to your layout lines. If you just began filing flat, you'd be bound to overshoot your line because the file cuts too quickly, and it's hard to tell exactly where the file is cutting. Then, too, filing across a flat surface inevitably produces a burr on the far edge, and that burr can hide the line.

Beveling the edges eliminates the burr, it allows the work piece to clearly show you where you need to file, and it helps you keep your file up away from the layout lines. Think of the bevels as sensitive mechanical amplifiers that change their widths in response to the removal of metal from the high spot (see the sidebar for a full description of the process).

More Tips on Precision

Once you've got precise blocks, you need to drill precise holes. I have no big secrets here, just a lot of little hints. Keep the block in the same clamping set-up for drilling and tapping. This time, I used wood clamps as shown in Photos 1 and 2 (easier to use than the bar clamps I used last time). The extra bit of scrap brass between the V-block clamp screw and the block in the photos is "furniture" to prevent the screw tip from mangling the edge of the block in which you've invested so much work.

Use new, sharp bits at the slowest speed of your drill press (less vibration with a cheap drill press). Use a 5/64" bit to drill the pilot hole because it won't flex as much as a 1/16" bit, and drill the pilot hole half way from both ends of the block to meet at the middle. More than likely the drill bit will wander off course, but at least you'll have two accurately placed starts. You can then use calipers to measure which hole is most accurately positioned on the block faces; choose that hole to step drill to 3/32" by 1/64ths.

Finally, a few places to inten-

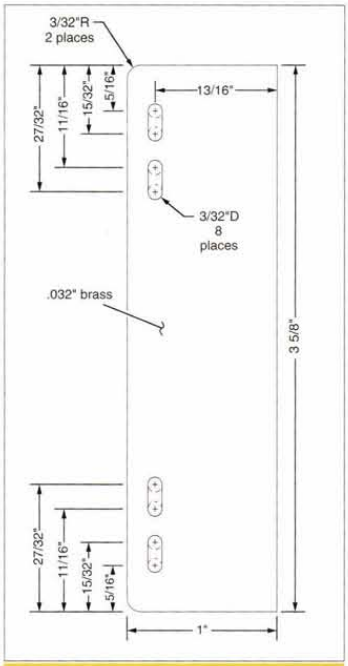


FIGURE 3: Limit switch mounting tab.

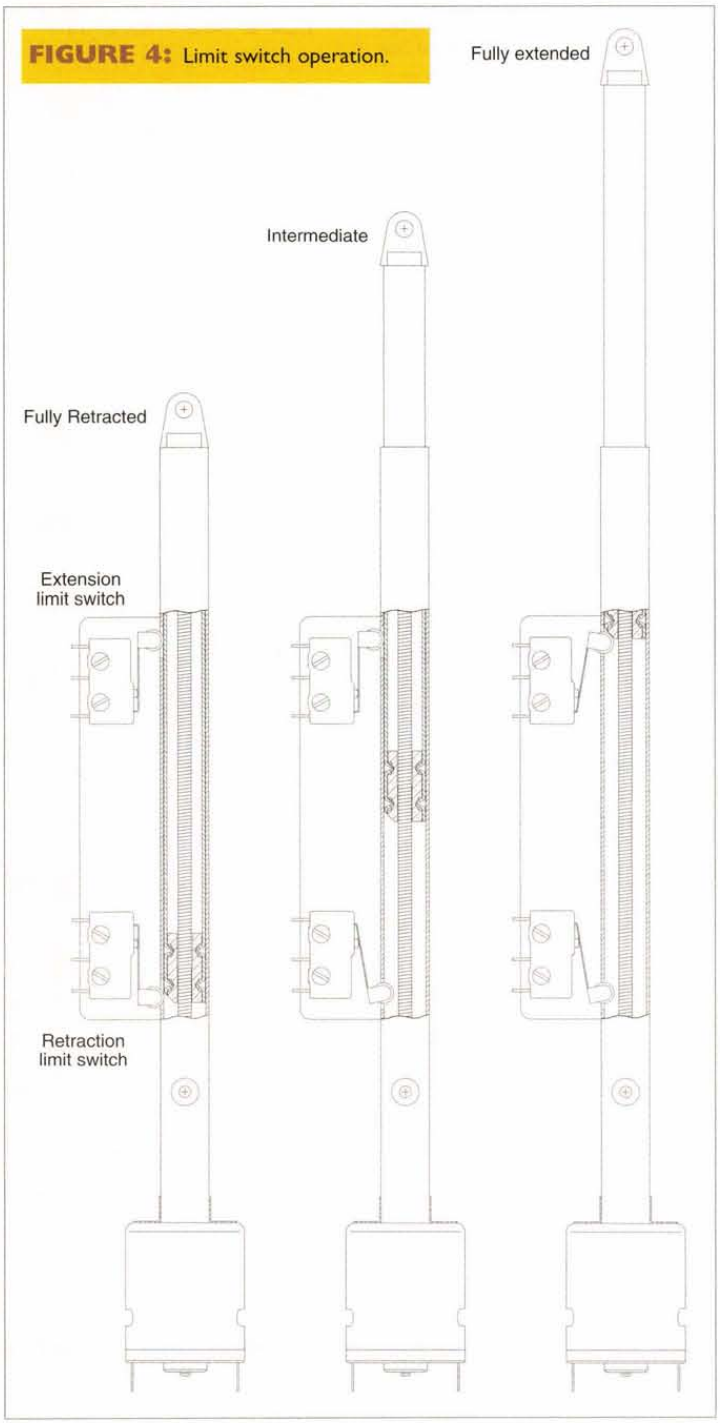


FIGURE 4: Limit switch operation.

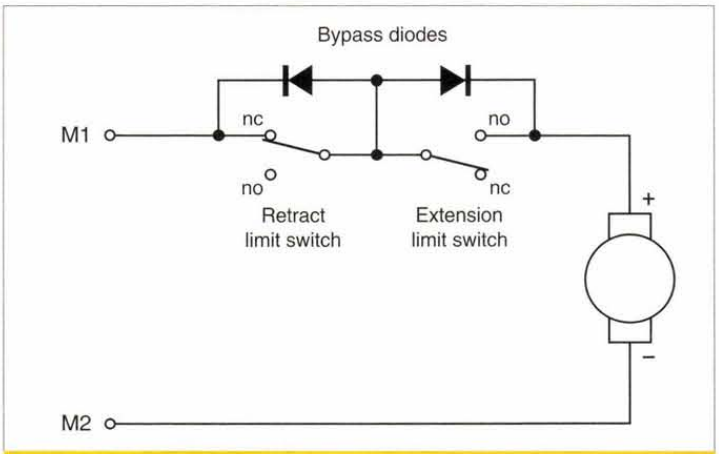


FIGURE 5: A simple limit switch circuit.

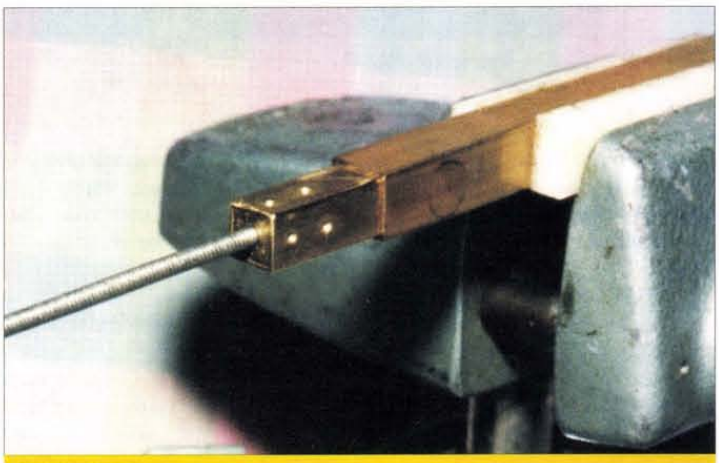


PHOTO 3: Here the follower nut is permanently mounted in the inner slide tube with center-punched dimples. Check that the tubes still have a loose sliding fit after the dimpling operation, filing as necessary to restore the correct fit. You may also need to run the tap once again through the nut to counteract any distortion caused by the dimples.

PHOTO 4: Filing the limit switch adjustment slots on the mounting tab.

tionally be less precise: the usual tap drill for 6-32 is a #36 bit, but use 3/32" for a looser running fit with the threaded rod; it makes alignment less critical since the threaded shaft can "wiggle" more. Since we only need half the block to be threaded, ream out to 5/32" from the less accurate hole to 5/16" depth.

Assemble the Slide Tube

Use Figure 2 to guide the following operations. Wrap brass shim around the follower nut block. Place sharply folded shim in the tube part way, then insert the block and tap the block and shim flush with the end of the tube.

Check how well you did on alignment by threading a 5" length of 6-32 threaded rod into the nut. With the tube held against a flat surface, note the deviation of the threaded rod from the ideal centerline.

If the threaded rod seems adequately aligned, take a deep breath and dimple punch to lock the follower nut in place. I used a center punch and a two-pound ball-pein hammer to make the dimples. I raised the hammer about a foot above the punch and let the weight of the falling hammer provide the necessary impact energy. No need to pound, just raise the hammer and let it

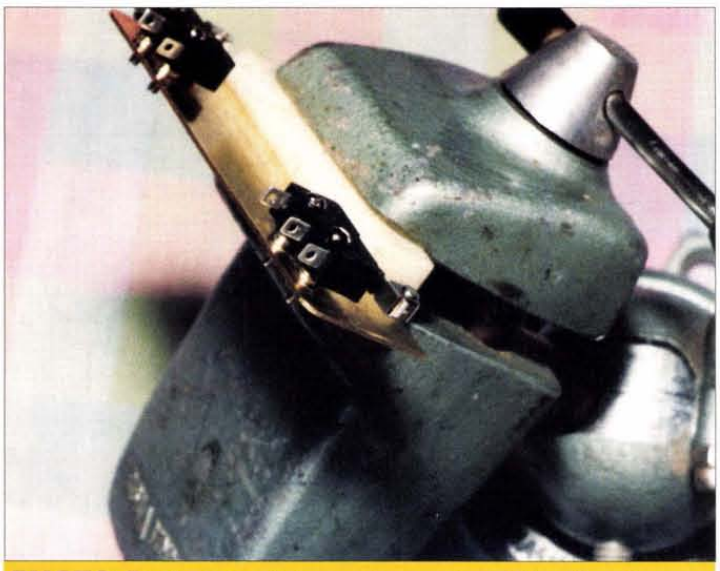


PHOTO 5: The limit switches on the mounting tab. Use #2 washers to space the switches up from the tab so their rollers are aligned with the centerline of the slide assembly.

drop. Dimple opposing holes in pairs, one blow per dimple until all eight have been done, then give each dimple one additional blow.

When you are done with the dimples, recheck the alignment of the threaded rod. You may need to chase the threads with the tap in case the dimpling operation distorts the threads. The final result is shown in Photo 3.

Do not bevel the edge of the slide tube assembly just yet. Instead, temporarily assemble the slide and guide tubes, along with the motor and threaded rod to test basic operation. You may need to do a bit of filing to get the tubes to slide freely after the slide tube has been dimpled.

Though it uses a 12V motor, my actuator still runs at 6V and even 3V. Try yours out at the lower voltages first. You'll be surprised how fast the slide moves, and the lower voltage will give you more time to react. When it all works smoothly, then you can bevel the slide tube as shown in Figure 2.

Adding Limit Switches

The actuator stroke is so swift you'll no doubt want to add limit switches right away, if only because you'll get tired of disassembling the actuator each time the follower nut runs off the end of the threaded rod.

The mechanical operation of the limit switches is shown in Figure 4 and the switch mounting tab is shown in Figure 3. The figures assume RadioShack # 275-017 roller switches, so if your switches have different dimensions, you'll have to make suitable adjustments to the mounting tab pattern (Photo 4).

The rollers of the limit switches must move freely through square openings in the side of the guide tube. Size the holes according to the dimensions of the rollers of your switches. Cutting square holes in the guide tube isn't hard, just tedious. Lay out the square holes, drill 5/64" pilot holes, enlarge to 1/4", then file the holes square to the scribed lines.

Mount the limit switches on the tab using 2-56 screws and washers to center the switches in the openings of the guide tube (Photo 5). Clamp the mounting tab to the guide tube with C-clamps to test and adjust the position of the switches. Once the tab is positioned, adjust individual switch positions in their slots to get the right action. Repeat the above two steps as needed until the limit switches work smoothly.

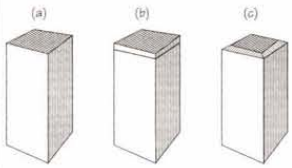
Once you are happy with the limit switch operation, scribe the final tab position on the guide tube. Disassemble the actuator and remove the switches from the mounting tab.

Tin the areas of contact between the tab and the guide tube, and lay the guide tube flat on a heat-proof surface with the tinned side up. Place the tab tinned side down on the guide tube using a scrap of 7/16" tube to level the tab. Use a high-wattage soldering gun or a small butane torch to "sweat" the tab and tube together. Feed extra solder to edges as needed.

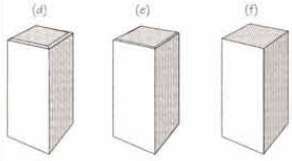
There's a limit ...

If you simply wired the normally-open contact of the extension switch and the normally-closed contact of the retraction switch in series with the motor, the actuator would work fine — until it tripped either limit switch.

How to file a block square

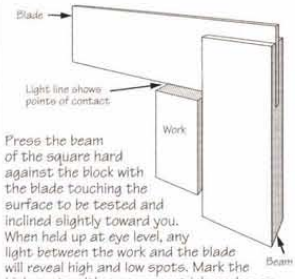


(a) Cut a rough blank from bar stock about 1/16" longer than the finished dimension, then debur rough edges of the saw cuts by light sanding or scraping; (b) Coat the side of the end to be filed square with permanent ink marker or layout dye, and scribe a square line around the bar about 1/32" from the rough end; (c) Bevel the edges at about 45 degrees to meet the scribed lines;



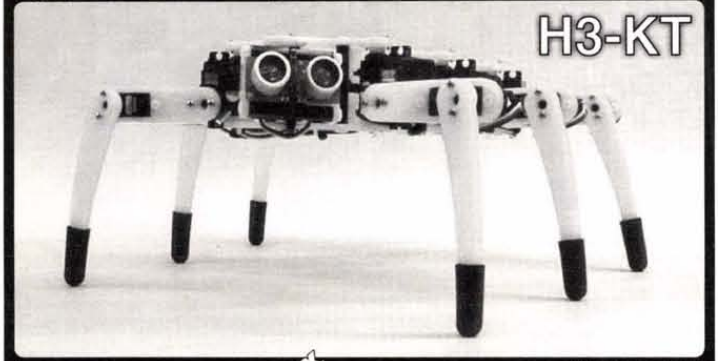
(d) file flat across the saw marks of the central raised area to even up the edges of that area framed by the bevels. Don't touch the surface while filing brass because the oil from your fingers will reduce the file's cutting action and contribute to "pinning." Use a clean rag instead to remove brass particles; (e) change filing direction by 45 or 90 degrees periodically so you can tell where the file is cutting. Use lighter strokes as the flattened area expands and the bevels shrink; (f) smooth file to scribed lines. Use machinist square and scraper as described below to make the surface dead flat. Repeat process for the other end.

Using a Machinist Square



Press the beam of the square hard against the block with the blade touching the surface to be tested and inclined slightly toward you. When held up at eye level, any light between the work and the blade will reveal high and low spots. Mark the high spots with a permanent ink marker so you know where to scrape next to true the surface. Never scrape without first testing and marking the high spots. Follow the sequence of checking and scraping in the positions shown below.

Lynxmotion, When you're tired of playing with toys!



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Then it would be stuck, and reversing the current wouldn't move the motor because the switch contact would still be open. A simple way around this conundrum is shown in Figure 5.

Here diodes bypass the switches to allow current to flow in the direction necessary to clear the switch. Just about any rectifier diodes rated for a couple amps and PRV of 100V or more will do.

There's also a limit to how much space I have in this column, and I've unfortunately run up against that limit.

Next time, I'll finish off a few loose ends of the actuator, and I'll begin a new project to take robots to the wonderful world of color. I'll also have a few quickie BEAM projects. See you then! **NV**

If you have suggestions, questions, or comments about amateur robotics topics, you can reach me at:

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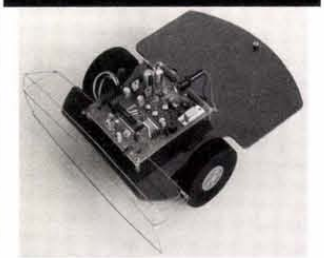

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Solid-State Voice Recorder Using Flash MSP430

By Murugavel Raju

The introduction of the flash MSP430 microcontrollers by Texas Instruments with its wide choice of peripherals has opened up unmatched flexibility in today's demanding microcontroller application designs. The solid-state voice recorder presented here is based on the MSP430F149 that belongs to the MSP430 family of ultralow power 16-bit RISC flash microcontrollers.

The MSP430F149 is a 64-pin QFP device with 60 Kilobytes of flash memory and integrated 12-bit A/D converter with internal reference. The fast in-system programmability of the MSP430 flash memory allows real time recording of the digitized voice. Not only does the MSP430 digitize the analog voice pattern using the integrated analog-to-digital converter, but also the voice data is stored in real-time in the MCU Flash memory and subsequently played back.

This application takes advantage of the ability of the MSP430 microcontroller to use the same memory array for both program execution and dynamic data storage. The in-system programmability of the flash and the long retention time of data in flash for up to 100 years make the MSP430 microcontroller ideally suited for these applications.

Figure 1 shows the block diagram of this design. The analog and digital blocks are marked accordingly. Arrowheads show the signal path from the microphone to the speaker. The peripherals used actively in this application are shown internal to the MSP430F149 block. Notice the integrated 12-bit analog-to-digital converter ADC12. The analog multiplexer integrated in the MSP430F149 allows eight channels of analog data to be input to the ADC12. In this design, only one channel 'A0' is used as analog input. The pre-amplified and filtered analog voice signal is directly input to the analog input 'A0' of the MSP430. During record, only the first two blocks are active and during playback, the last two blocks are the active blocks. During playback, the stored voice signal data is sent to the serial DAC via the MSP430 USART SPI. The active filter based on a TI opamp filters the digital-to-analog converter output. This filtered signal is then amplified by the audio power amplifier section and drives a miniature speaker to play back the stored voice information.

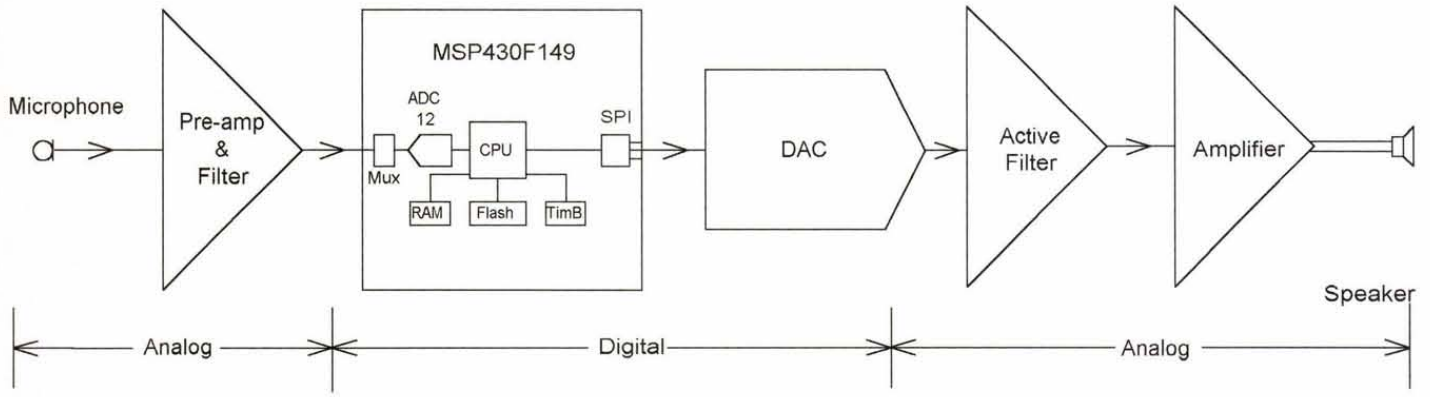
Circuit Description

Figure 2 shows the complete schematic of the design. The condenser microphone picks up the voice and converts it into an analog signal. The analog voice signal is then amplified by a TI opamp TLV2252 (Reference [3] is the datasheet for this device). The TLV2252 is a low-voltage and low-power dual opamp, one of which is used for microphone signal amplification and the other in an active low-pass filter circuit associated with the DAC. The TLV2252 is chosen because of its capability to operate at three volts with a low-operating current. The amplified analog signal is bandwidth limited to the required voice spectrum before it is input to the integrated A/D converter of the MSP430F149. A simple RC filter at the output does the bandwidth limiting with a cut-off frequency approximately 2.7 kHz. The capacitor C4 across the feedback path also provides some high frequency roll-off. Technically this filter serves as the anti-aliasing filter and is required to avoid frequency aliasing of the input signal that could arise after sampling. Bandwidth limiting to 2.7 kHz is essential to satisfy Nyquist since a sampling frequency of 5.5 kHz is used in this design. The sampling frequency of 5.5 kHz is picked as a trade-off between voice quality and maximum duration of voice that can be stored in the flash memory. With the above values, approximately six seconds of speech can be stored in the flash. The digitized 12-bit voice data is directly stored in the flash without any compression. Compressing the voice data using A-law or u-law to eight-bits doubles the storage time to 12 seconds.

The analog output portion is the serial DAC and the output filter circuit. The TI data converter device TLV5616 DAC used in this application features three-volt operation (Reference [4] is the datasheet for this device). The DAC interfaces with the integrated hardware USART of the MSP430 configured in SPI mode. The MSP430 SPI handles the required 16-bit word transfer to the DAC by taking advantage of the double-buffering capability of the integrated hardware USART module. The TLV5616 is a voltage output DAC that directly interfaces with the output filter circuit built with the TLV2252 opamp. This filter is a second-order Sallen-Key active low pass filter circuit that filters the sampling edges from the DAC output. The filtered output needs further amplification before it can be made audible by the speaker.

Finally, consider the audio power amplifier circuit. This is based on the TI audio power amplifier device TPA721 (Reference [5] is the datasheet for this device). The TPA721 has a wide power supply com-

Figure 1. System Block Diagram.



patibility of 2.5V to 5V. The BTL (bridge-tied load) design of the output stage of the TPA721 provides approximately 6 VPP drive to an eight-ohm speaker at a supply voltage of three volts. The BTL also eliminates the need for a speaker coupling capacitor. The TPA721 is available in an MSOP footprint called the PowerPADTM that allows a compact PCB design to be realized. Notice that an RC low-pass filter built around R13 and C9 — also known as the power supply de-coupling circuit — is shown in Figure 2. This RC circuit filters the voice signal superimposed on the battery supply by the power amplifier, before it is fed to the analog circuitry.

The digital hardware is the MSP430F149 flash microcontroller and its associated passive components (Reference [1] is the datasheet for this device). The integrated peripherals simplify the digital design and this application is a good example for MSP430 being a "System in a Chip." A 3.58-MHz ceramic resonator clocks the MSP430. The resonator used in this application has built-in load capacitors for the internal clock oscillator circuit. Timer B7 is used to generate the timed interrupts for the sampling frequency. Timer B7 is clocked by the stable 3.58-MHz clock as any jitter in this would reflect as jitter in the sampling frequency and affect the voice quality. The sampled analog voice signal is digitized by the integrated ADC12 peripheral of the MSP430. Take care in interfacing the analog and digital circuits. Notice that the analog and digital grounds are shown separately. Also the analog and digital supplies must be separated out as shown in the schematic to comply with A/D grounding and noise considerations.

The digitized voice data is stored sequentially in the flash memory. During playback, the stored data is transmitted to the serial DAC in the same order as it was stored during recording and using the same rate as the sampling frequency, via the MSP430 hardware USART module configured in SPI mode. The DAC converts these data patterns to the original voice signal and the following filter and amplifier circuit renders it audible via the speaker.

Software

The code for this application is written in assembly language, using the IAR KickStart integrated development environment. The MSP430F149 has 120 segments of main memory starting from 1100h to FFFFh. Segment 0 to segment 118 are 512 bytes wide and segment 119 is 256 bytes wide. Segment 0 carries the interrupt vectors and must not be modified during run time. Two more segments called Segment A and B each 128 bytes wide are allocated as information memory in the device. The user can use this information memory for storing device identification codes. The information memory can also be used to substitute an EEPROM or can be used to store executable codes depending on the assembler definition. The information memory is left unused in this application. Please refer to the MSP430F149 datasheet, reference [1], for memory mapping of the flash memory in the device.

The executable code for this application vectors at 1100h, the start address of the main memory. The compiled code size is 346 bytes and occupies segment 119 (256 bytes) and segment 118 (90 bytes out of 512 bytes). Segment 0 is programmed with the interrupt vectors. The remaining segments 1 to 117 are allocated by software to store the digitized voice data. This is referred to as record memory array and is 117 segments wide (59904 bytes) starting at 1400h and ending at FDFFh. During recording, the voice data words are sequentially written into this flash memory array, and during playback, the voice data words are sequentially read from this array.

The software implemented runs the application in two modes — Playback and Record — depending on the status of the record push button. As soon as the system is switched ON, it goes to the playback mode and plays back any previously recorded voice message. The playback is repeated continuously as long as the system is switched ON. To enter Record mode, the following steps are to be followed. While the system plays back a message, hold the Record button. The LED lights up in a moment indicating that the flash memory is erased and ready for a new recording. Release the button and speak into the microphone. The voice is stored in the flash and when the Record Memory array reaches its capacity, the LED goes OFF, indicating that the recording is over. Now the recorded voice is automatically played back continuously as long as the system is switched ON.

Note that the flash memory can be erased and programmed only if the MSP430 supply voltage is greater than or equal to 2.7V. Please refer to the device specific datasheet. If it falls below 2.7V because of the draining battery, the system cannot record voice. However, it plays back the previously stored message a few more times until the voltage drops below the operational level of the analog circuitry.

Construction

I built the prototype using a double sided through plated PCB designed using PCAD. I used the MSP430 flash emulation tool (MSP-FET430P140) to develop and debug the code and to program the device. You can also use the MSP430 serial programmer (MSP-

References

Franco, Sergio. *Design with Operational Amplifiers and Analog Integrated Circuits*. New York: WCB McGraw-Hill, 1998.

Texas Instruments Datasheets:

1) MSP430F149 Mixed Signal Flash Microcontroller datasheet (SLAS272)
2) MSP430x1xx Family User's Guide (SLAU049)
3) TLV225x Rail-To-Rail Low-Voltage Low-Power Operational Amplifier (SLOS185)
4) TLV5616 Low Power 12-Bit Digital-To-Analog Converters (SLAS152)
5) TPA721 700-mW Mono Low-Voltage Audio Power Amplifier (SLOS231)
6) MSP430x14x Application report (SLAA123)

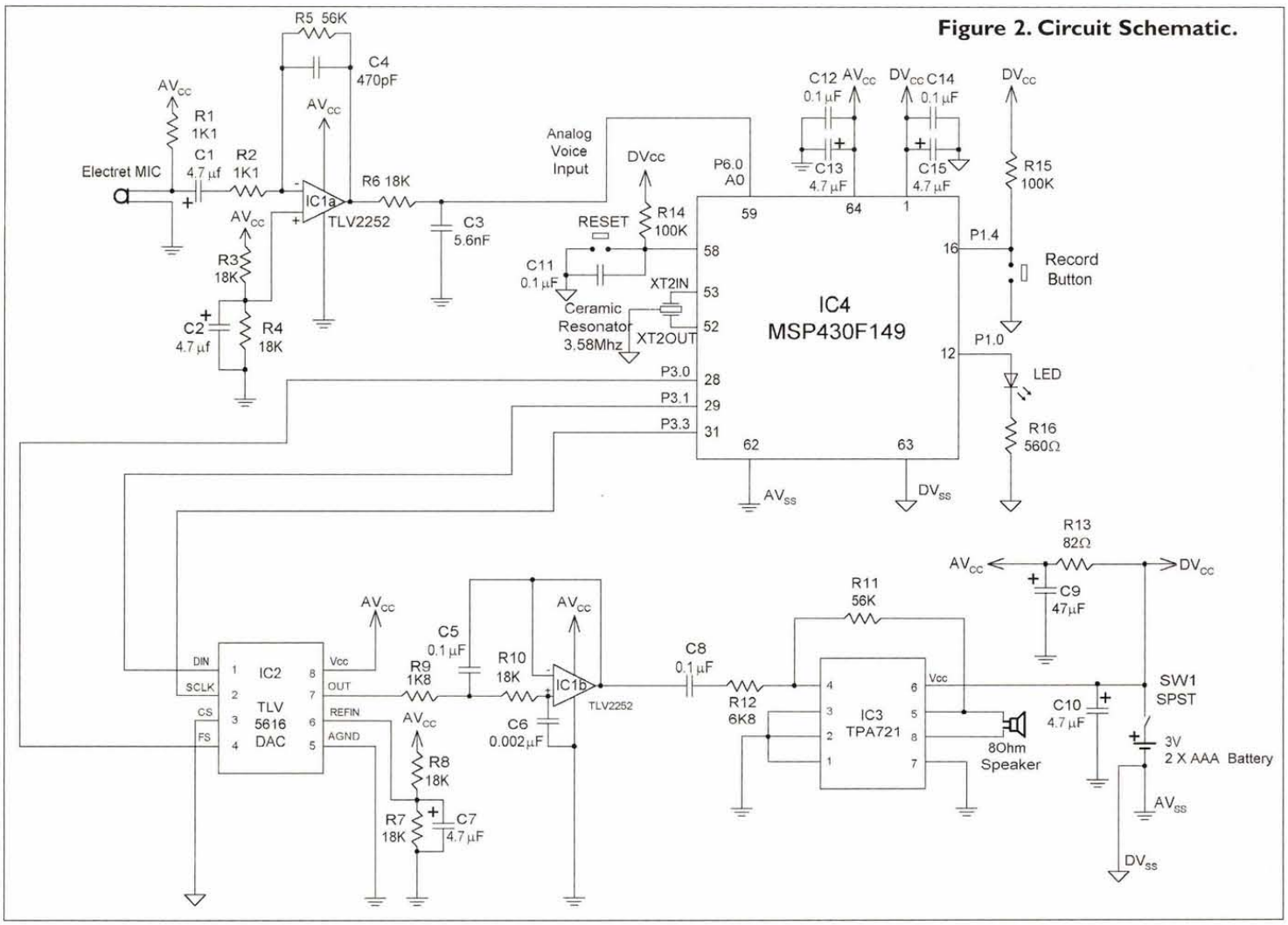


Figure 2. Circuit Schematic.

PRGS430) to program the MSP430 device. Both tools use the JTAG port of the MSP430 to communicate with the device. The flash emulation tool (FET) has the advantage of providing in-system debugging capability. The FET tool is a low-cost MSP430 development tool offered by Texas Instruments and combined with the JTAG on-chip emulation logic of the MSP430 rules out the requirement of an ICE (in circuit emulator) for microcontroller application development.

Conclusion

The integrated 12-bit analog-to-digital converter, the 16-bit timer, the in-system programmable flash memory, and the flexible hardware USART peripherals simplify this voice recorder application design and the MSP430 provides a true system-on-a-chip solution.

Longer recording duration can be achieved by employing voice compression like A-law or u-law and additional capacity can be achieved by interfacing an external serial flash memory to the free hardware USART module; the MSP430F149 has two hardware USARTs programmable in asynchronous (UART) or synchronous (SPI) modes. The low power operation of the MSP430 and the chosen analog components for this design allow three-volts operation running out of 2 X AAA batteries. **NV**

Murugavel Raju currently works as Systems Engineer for Texas Instruments. He was selected as the Worldwide winner of the first Texas Instruments Analog Challenge in the year 1999 **(www.ti.com/sc/cash)** and won the grand prize. He may be reached at **m-raju1@ti.com**.

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Putting the Spotlight on BASIC Stamp Projects, Hints, and Tips

by Jon Williams

Stamp Applications

Objects in the Machine

A long time ago, in a galaxy far, far away[1] ... Actually, it was the early 90s and it was in Palo Alto, CA – at about the same time the BASIC Stamp was being developed – the guys at Sun Microsystems were working on a little language called Oak that they hoped would change the way we program microcontrollers.

The idea was to create a clean, easy, object-oriented language that could be used on a variety of small micros; the concept that one program would work on any micro – cross platform compatibility was the goal.

Due to a naming conflict with another product, Oak was changed to Java[2]. Coincident with the later stages of its development was the public emergence of the Internet. The nature of the Internet and the variety of operating systems connected to it was ideally suited for the cross-platform approach designed into Java. Java's target changed and it became a contributing factor for the wild success and proliferation of the Internet and World Wide Web.

Pity, really, that they didn't keep working towards the small micros since Java is a very nice language. It has, in fact, garnered tremendous acceptance from programmers and recently with educational institutions. Most universities and many high schools are switching from teaching C and C++ to teaching Java. Well, it took a while, but Java is finally available in a microcontroller format.

Parallax isn't the first to do it, but just as the case was with the BASIC Stamp, Parallax has made it clean and easy with the Javelin Stamp. So, if you're a C/C++ or Java programmer wanting to explore the world of embedded control, now you can do it with a product from a company famous for its reliable products and after-sale support – and you can do it with a cool little 24-pin DIP package.

This article is written for those PBASIC programmers who are new to Java, bought a Javelin for all its cool features and power, and have worked your way through the programming tutorials in the manual. If you don't have a Javelin starter kit yet, that's okay, too. Just be sure to download the manual (it's free) and read through chapters 2, 3, and 4 – or none of this will make any sense

Let's say that you do have a Javelin and have played with the tutorial examples. Now you're excited, now you want to create your own classes ... but wait, this isn't quite as straightforward as programming a BASIC Stamp. No, it isn't, but you know what? Taking the time and putting the effort to learning Java properly is worthwhile, especially as you start to fill that 32K code space and take on increasingly sophisticated tasks.

Footnotes

(1) From "Star Wars" by George Lucas.

(2) Java is a registered Trademark of Sun Microsystems.

OOP For Regular Guys (And Gals!)

You've probably heard the term Object Oriented Programming (OOP) before, but what does it mean, exactly? It becomes self-evident when we understand the programmer's definition of an object. An object is a [software] mechanism for bundling data (variables) and the means to manipulate that data (code). This bundling is called encapsulation. In procedural (action-oriented) languages like BASIC, data and code are separated. Not so with Java. In Java, objects contain both data and the code (behaviors) necessary to manipulate or use the data. They are fully self-contained. In a Java program, objects pass messages to each other. This is the nature of Object Oriented Programming.

Why should we care about this? Well, for one thing, it can make things easier by hiding gritty details (this is especially nice when you're using code written by someone else). The biggest advantage, though, is that it makes reusing code very easy – saving lots of time for programmers. We'll see both of these concepts in action with our little demo program.

Let's Just Do It

The easiest way to get your arms around Object Oriented Programming is to just haul-off and do it. So we will. We'll keep it simple so that we can grasp Java concepts and get used to the way the Javelin does things. Since all programming tutorials start off with a "Hello World" program and with microcontrollers we say "Hello" by flashing an LED, that's what we'll do. Yes, yes, I know it sounds amazingly trivial, but I promise that the exercise is a good one.

Most of us don't think twice about LEDs because we've used them so many times. And herein lies one of the keys to succeeding with an OOP language like Java: thinking about it – a lot – at first will save you hours of code rewriting later. OOP programs need to be designed, not simply written. An LED is a good place to start with OOP, since it's a real-world object that is easy to model with software.

It becomes pretty interesting when we actually stop to think about what concerns we could have when connecting an LED to a microcontroller. What pin will we use? How will we control it? When we know these things, then we can create code (called methods in Java) to turn it off, turn it on, control it indirectly, invert its current state, and to report what it's doing at the moment.

Before we look at the LED code, let me remind you that all Java programs are composed of one or more class files. To create an object definition, we'll write a class file with the same name as the object type we're defining. It's important to distinguish the class file (definition) from the actual instance of an object. My friend, Al, told me to think of an object's class file like a cookie-cutter. It isn't the object itself, it's what gives the object its "shape" – so to speak. What you'll find as you spend more time with Java is that one class can be extended to create a more complex version. This is what is meant by inheritance: the new class inherits all the capabilities of the class used to build it.

Time to jump in and take a look at Listing 1, the LED class.

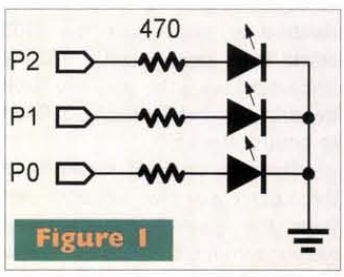

Figure 1

From this definition, we'll be able to create LEDs to our heart's content and control them with ease.

One of the first things you notice is an import line. What this is doing is importing (gaining access to) all (*) of the classes in the core package [folder]. The classes in this package have to do with the Javelin's hardware, specifically the CPU class. We'll be using a couple methods from the CPU class to control the pin that controls our LED.

At the top, we define a couple of constant (final) values to indicate the current state of the LED. The constants have values of true and false, respectively, because an LED is either on (true) or off (false). These constants are public so they will be the same for every LED object we create.

Next come a few private variables (called fields in Java). It's important that these values are private because we need them to be different for every LED object we create. And being private, they're hidden from the outside world. In order to change these variables, we'll create methods to access and manipulate them.

In a tangible class (there are abstract classes that are used as the base for others) like LED, the first method we'll deal with is special; in fact, it has the same name as the class. This method is called the constructor. The constructor does the work required when creating a working object. Some classes have multiple constructors (using a technique called method overloading) that allow an object to be created by more than one means. We'll keep it simple and just have one constructor in our LED class.

In our case, we're going to set the pin to use, how we control the LED, then make sure it's off. Notice the use of the word "this." While not strictly necessary, it does help clarify the code a bit. The use of "this" indicates the object's fields, not the parameters passed. The final line of the constructor calls the LED.off() method to make sure the LED starts in a known state. This is important since the pin may have been in use before being defined to control the LED.

Now we can add methods to the LED class that actually perform the control we discussed earlier: turn it off, turn it on, follow an external value (indirect control), invert its state, and report what it's currently doing.

The first method is called, big surprise, off(). This method works by calling the CPU.readPin() method. Remember that CPU.readPin() method is normally used to report the state of an input pin, so it starts by making the specified pin an input. In our case, this will safely extinguish the LED. We save the new state (off) so it's easy to retrieve later and we don't have to rely on examining hardware for the current LED state.

Our next method is used to turn the LED on. This uses the CPU.writePin() method which, of course, is used to make a pin an output and set it high or low. To set a pin high, we pass a value of true; to set it low, we pass a value of false. In our case, the pin will be the LED connection we passed to the constructor and the control value will be what we set in the onState field. Once again, we save the new state (on) so we can refer to it later.

There may be times when we want the LED to follow the value of another variable or logical condition so a method that will allow that is convenient. This is the purpose of the putState() method. This method requires a Boolean value (true or false) to be passed to it. If the value passed is true, the LED will be lit. If false, it will be extinguished. This is very easy code since we've already written methods to turn the LED on and off. Note that the value passed is not related to how we control the LED — true means on, false means off; no matter how the LED is connected.

An easy way to blink an LED is to invert its state inside a loop with a bit of a delay, so let's create an invert() method. This method sends the inverted (!) ledState value to the putState() method. Simple, huh?

Finally, there will be times when we want to know if an LED is on or off — without remembering and dealing with the connection and control details. This is the purpose of the getState() method. Notice that this method is defined as a Boolean type since it returns a value of true or false. The other methods we've created don't return anything so they are defined as void. Since we've previously saved the state of our LED, it's a simple matter of returning it to the caller.

Now, to those of you who are PBASIC fanatics (like me), this may seem like an amazing amount of work just to manipulate an LED. It only seems that way now. What you'll find after you've worked with the Javelin a bit is that this up-front work makes the down-the-road stuff a breeze, especially when it comes to bigger programs and more complex objects.

LEDs In Action

Okay, time to make this stuff work and show the elegance of Java in action. The circuit is a no-brainer: three LEDs and three resistors —probably stuff you have within an arm's reach of you computer.

The working code is in Listing 2. As with all Java programs, this is a class file too, but this class doesn't define an object. As I stated earlier, a Java program is made up of one or more classes. Java knows where to start because it always starts with the method called main(). So, we'll have a main() method in this class since it's this code we want to run.

As with most of our Javelin programs, we'll import the "core" classes and, of course, we'll import our new LED class so we can use it.

Now we get to the good stuff — using our LED class. Using standard Java syntax and referencing our new object class, we'll create three LED objects: one green, one yellow, and one red. These are simple names for our demo. Take advantage of Java's verbose nature and name your objects and variables so that your programs are easy to read. An HVAC project, for example, might have LED objects called acCooling and acHeating.

At the end of our demo, we're going to do some precision timing, so we'll define a timer for each — and give them an appropriate name. Timers use a special Virtual Peripheral (VP) that runs in the background. The Javelin has several virtual peripherals and up to six can run at the same time. The nice thing about timers is that only one VP slot is used, no matter how many timers we define. Other VPs include UARTs for background serial communications, a PWM VP that's perfect for servo and motor control, A2D and D2A conversion.

Back to our LEDs; let's start with the basics. And now we see the fruits of the work we went through to design the LED class. How easy is this?: green.on(). Could we make it any more obvious? If so, I don't know how. And this is part of the point. Well-designed code is easy to read and understand without a lot of additional comments. That applies to any programming language, but Java is particularly supportive of this concept.

Since we know how our object code works and the rest of the basic demo is easy, let me just explain that the CPU.delay() method is identical to PBASIC's PAUSE command except that it takes a parameter in 100 microsecond (0.1 millisecond) units. So, a delay of 5,000 units is a half second.

Now for the timers, because these are incredibly useful. Once we've defined a timer, we start it with the mark() method. We can check to see if a given timer has reached an elapsed time (in milliseconds) with the timeout() method that passes a single parameter. This will return true if the timer value is equal to or greater than the value passed (there is another version of the timeout method that allows even greater resolution).

So here's what's happening at the end of the code. We've created a very tight while-loop that checks on the timers for each LED. When a timer expires (timeout () returns true), we restart that timer and invert the state of the associated LED. In the end, you'll see all three LEDs flashing at completely independent rates.

Resources:

Jon Williams
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www.javelinstamp.com

Javelin Stamp
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This is a neat demo, right out of the Javelin manual. But now extend this idea beyond flashing LEDs. How many of your projects could benefit from launching specific chunks of code at precise timing intervals? A lot, I'll bet.

In the end, the question begs to be asked ... Did we really need to create a class file to control an LED? Of course not. That said, which line of code do you think is more obvious?:

```
alarmLED.on();
```

or ...

```
CPU.writePin(CPU.pin0, true);
```

Both are valid. Both work. Only one tells us exactly what's going on. Java requires a little bit of discipline and yet it pays tremendous dividends for doing so. Besides, if you don't have time to do it right, when will you find time to do it again?

Where Do We Go From Here?

If you've worked your way through the manual and started to play, you might do what I've been doing to learn the Javelin: I've been porting some of my favorite BASIC Stamp projects and code snippets — especially those things I tended to use a lot as they're perfect candidates for object class files. If you want more reference material, there are over 1,000 books available on Java programming. Almost none of them deal with embedded programming, per se, but they do teach Java well and most of the code will run with little or no modification on your Javelin.

Also keep an eye on the Javelin web site for new code and application notes. As Parallax (and others) develop new class files, they will be documented and posted. This will, ultimately, save us all a lot of work and allow us to focus on designing solutions instead of churning out grunt code. And make sure you join the Javelin Stamp group (on Yahoo! Groups). That will keep you in touch with other Javelin programmers.

How Fast Did You Say?

The readers of this magazine are sharp. Very sharp. Several caught my horribly glaring error in last month's column.

The correct speed of sound is, of course, about 1,130 feet per second at sea level — in dry air at 72 degrees Fahrenheit. That's a far cry faster than the 0.9 feet per second that I quoted. Please accept my apology for the error. I was referencing an old [incorrect] SRF-04 tech sheet. Still, it's my responsibility to verify technical data that I don't generate myself. I'll do that in the future.

To me, the only thing more appealing than an intelligent person is an intelligent person with a sense of humor. One reader suggested that the reason Texans apparently speak more slowly than the rest of the world could be accounted for by my speed of sound error. Funny. Very funny. Truth be told, I'm a native Californian currently living in the great state of Texas — and I wouldn't have it any other way.

I think you'll agree that the Javelin is very exciting. If we look back and see all the cool things the BASIC Stamp has done, one can only imagine what the Javelin and its programmers will do ...

Until next month, happy Stamping — in PBASIC or Java!

NV

Listing 1

```
package stamp.peripheral.io;

import stamp.core.*;

/**
 * This class encapsulates the basic operations of a standard LED.
 *
 * @author Jon Williams, Parallax Inc.
 * @version 1.0 03 April 2002
 */
public class LED {

  public static final boolean LED_OFF = false;
  public static final boolean LED_ON  = true;

  private int ioPin;
  private boolean onState;
  private boolean ledState;

  /**
   * Creates an LED object.
   *
   * @param ioPin LED control pin
   * @param onState Output state of control pin to light LED
   */
  public LED (int ioPin, boolean onState) {
    this.ioPin = ioPin;
    this.onState = onState;
    off();
  }

  /**
   * Extinguishes the LED
   */
  public void off() {
    CPU.readPin(ioPin);
    ledState = LED_OFF;
  }

  /**
   * Lights the LED
   */
  public void on() {
    CPU.writePin(ioPin, onState);
    ledState = LED_ON;
  }

  /**
   * Controls LED with external variable/condition
   *
   * @param ledState New state of LED (false or true)
   */
  public void putState(boolean ledState) {
    if (ledState)
      on();
    else
      off();
  }

  /**
   * Inverts state of LED
   */
  public void invert() {
    putState(!ledState);
  }

  /**
   * Returns LED status
   *
   * return LED status (LED_OFF, LED_ON)
   */
  public boolean getState() {
    return ledState;
  }
}
```

Listing 2

```
// LED object demonstration
// by Jon Williams
// jwilliams@parallaxinc.com
//
// 03 MAY 2002

import stamp.core.*;
import stamp.peripheral.io.LED;

public class HelloLEDs {

  public static void main() {

    // create LEDs
    LED green = new LED(CPU.pin0, true);
    LED yellow = new LED(CPU.pin1, true);
    LED red = new LED(CPU.pin2, true);

    // create timers for LEDs
    Timer greenTimer = new Timer();
    Timer yellowTimer = new Timer();
    Timer redTimer = new Timer();

    // demonstrate LED basics
    green.on();
    CPU.delay(5000);
    yellow.putState(true);
    CPU.delay(5000);
    red.putState(yellow.getState());
    CPU.delay(5000);

    green.off();
    CPU.delay(5000);
    yellow.putState(false);
    CPU.delay(5000);
    red.invert();
    CPU.delay(5000);

    // start the timers
    greenTimer.mark();
    yellowTimer.mark();
    redTimer.mark();

    // flash LEDs at different rates
    while (true) {
      if (greenTimer.timeout(250)) {
        greenTimer.mark();
        green.invert();
      }
      if (yellowTimer.timeout(333)) {
        yellowTimer.mark();
        yellow.invert();
      }
      if (redTimer.timeout(1000)) {
        redTimer.mark();
        red.invert();
      }
    }
  }
}
```

TECH FORUM

QUESTIONS

I have a problem with my BS2. I can download my program from my computer, and it works great. However, if I "reset" the stamp with the reset pin or if I unplug the power, it seems like the program is nowhere to be found on the Stamp's memory.

#6021 **Jason Mantey**
via Internet

Are there any circuits out there or a device that could convert an infrared signal to a serial and analog output? I would like to convert the infrared signal that is coming out of a cellular phone to a serial port so that I could connect other custom devices including a computers serial input.

#6022 **J. Mackey**
via Internet

I am looking for a high-voltage circuit to be used on a gas cooking grill.

My uncle builds gas grills for a living and we have been using a push-button crystal ignitor. The problem we are having is this is a mechanical device and you can buy only in one length and, of course, they don't last long.

We visited a trade show for home cook ware show and there was a vendor who used a high-voltage circuit tied to a car spark plug that is mounted next to the gas to ignite the gas. This unit ran on a 12-volt, one-amp battery and used a car automotive coil. Where can I find this circuit?

#6023 **Douglas Back**
via Internet

Having salvaged numerous motors from hard drives (the ones that spin the hard disk), I finally came up with an application. My problem is that I don't know how to wire these. They appear to come with some control circuitry built in, and they have several connecting wires. For example, one of them, a Nidec 4515-3BCA-01 (P/N004060802) has six connecting wires. All I'd like to do is to get this motor to run at full speed. Suggestions on how to accomplish this would be appreciated.

#6024 **Axel Schmetzke**
Stevens Point, WI

Cadmium zinc telluride (CZT) devices make great nuclear radiation detectors, but I've been unable to find any circuit diagrams to build one. Has anyone had any experience with these?

#6025 **Bob Grove**
via Internet

I have a 35mm SLR camera. I was wondering what circuit is behind the camera flash trigger. I measured the flash trigger and it read around 0-.05 VAC and when I pressed the shutter button it jumps to .33 VAC, then it trickled back down.

I would like to be able to trigger a relay or turn on a transistor, but this AC voltage is so low. What kind of simple circuit do I need?

#6026 **Qui Nguyen**
via Internet

I am looking for a small audio playback board that has a non-volatile memory with an onboard amp. It needs to be as small as possible to be incorporated into a handheld prop. I want one that is programmable from a PC under Windows. The quality of the playback should be of fair quality as it will be feed through a small speaker say 1" in size or so. I would also like to be able to select from two or more sound samples for playback.

#6027 **Gary Houser**
via Internet

I have heard, but not seen, that it is possible to control an air conditioner motor, or other large motor, with PWM. I am curious if it is possible to build a circuit that takes a TTL level PWM signal and switches 230 volts DC 20 or 30 amps at a 20 kHz rate. I would like to use this to add specialized speed control to my table saw.

Some people have mentioned IGBTs as a solution, but I don't know what they are.

#6028 **Craig**
via Internet

I have a portable CD player. I'd like to use the radio speakers in my car to broadcast its music, so I don't have to drive with earphones. I thought of buying a FM transmitter, that would allow the player to act like another FM station — but they seem way overpriced.

Can somebody provide me with an inexpensive, simple circuit I can just build?

#6029 **Thomas Ng**
via Internet

I need a diagram for a variable current control for my AC arc welder. I have two SCRs p/n 205a5981p1 3/4" stud mount ... the voltage is between 30 and 50 volts. The max current will be 225

This is a READER TO READER Column. All questions AND answers will be provided by Nuts & Volts readers and are intended to promote the exchange of ideas and provide assistance for solving problems of a technical nature. All questions submitted are subject to editing and will be published on a space available basis if deemed suitable to the publisher. All answers are submitted by readers and NO GUARANTEES WHATSOEVER are made by the publisher. The implementation of any answer printed in this column may require varying degrees of technical experience and should only be attempted by qualified individuals. Always use common sense and good judgement!

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- Include the question number that appears directly below the question you are responding to.
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- The question number and a short summary of the original question will be printed above the answer.
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All questions should relate to one or more of the following:

1) Circuit Design
2) Electronic Theory
3) Problem Solving
4) Other Similar Topics

Information/Restrictions

- No questions will be accepted that offer equipment for sale or equipment wanted to buy.
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Helpful Hints

- Be brief but include all pertinent information. If no one knows what you're asking, you won't get any response (and we probably won't print it either).
- Write legibly (or type). If we can't read it, we'll throw it away.
- Include your Name, Address, Phone Number, and email. Only your name, city, and state will be published with the question, but we may need to contact you.

amps, the min will be 35 to 40 amps.

#60210 **Steve**
via Internet

I'm looking for an IC-like or similar to the MC145028P in the April wireless remote control article. The object is to decode the X10 remote controls model KR21A, KR19A, or other X10 control devices. I wish to build a receiver DC version for remote control. I have a Ming 310 receiver board. Would adapt.

#60211 **John Pineau**
via Internet

ANSWERS

[2023 - FEB. 2002]

I have a Dunn MP-979 laptop, manufactured by Chicony. It has an internal CD-ROM, but will also support an internal DVD drive in place of the CD-ROM.

I want to upgrade, but I don't know what brand or model DVD drive will fit into this system and Chicony has closed down its laptop division and no longer provides any information or support.

I found a supplier of DVD drives for this laptop: (and its two brothers the MP-978 and MP-989) **www.orphanlaptops.com/mp978_mp979_mp989_parts.htm**. They also have Zip and LS-120 drives.

Amos Bieler
Springfield, MO

[3027 - MAR. 2002]

How does a DC clamp meter work? Is it based upon Hall-Effect transistors?

Can someone provide a low-cost circuit for a 10-60 amp DC clamp meter using a digital panel meter?

A circuit using a CSLA1CD Hall-Effect Sensor from Microswitch was originally published by EDN and is reprinted on p 255 of Rudolf F. Graf's *Encyclopedia of Electronic Circuits Vol. 3*.

It has a range of 0-40 amps and uses a linear Hall-Effect sensor in a small gap of a toroid. However, I recommend going with a Fluke AC/DC current clamp, since it is probably nearly impossible to get the parts.

If you do not have the need for an isolated/temporary measurement, I recommend using a shunt arrangement due to the better accuracy. (Hall-Effect gets about 3%, shunt can get you easily to 0.05%.) Shunts are available through Industrial Suppliers in single piece quantity and can be connected directly to a sensitive digital panel meter.

Walter J. Heissenberger
Hancock, NH

[3029 - MAR. 2002]

The clock in my 1989 Mercury has a problem. The digits light and it keeps time, but the set functions don't work. I tried cleaning the contacts and this was no help. Also, the resistor seems to be running hot. Appreciate any tips on getting this thing to work.

I am not familiar with your particular clock module, but I have seen several different modules. All modules either have integrated switches like on a calculator or use discrete push-button switches. In either case, you have to verify their operation with an ohmmeter (make sure ignition is off). If the switch contacts are worn out or deformed (from heat), cleaning them will not help, you need to replace them.

Regarding the resistor getting hot, if it is not badly discolored, it is probably normal. Assuming the resistor was properly rated to begin with. By definition, that is what resistors do. They either drop voltage or limit current, which generates heat.

Haim Sandel
Phoenix, AZ

[3028 - MAR. 2002]

I want to drive an LCD display from a computer with a VGA output using a VGA/NTSC converter. The display has a NTSC input and a resolution of 1152H x 234V. Would this work for displaying text and graphics? The VGA is 640 x 480 and I wonder if this would work with the resolution of the display.

Many manufacturers make a VGA-to-NTSC converter for less than $100.00. One company which advertises regularly in *Nuts & Volts* sells such a converter for $99.99 and has outputs for composite, S-video, and RGB. Other units are similar and have soft-

[4027 - APR. 2002]

What type of DC motor and controller could be used to obtain a smooth non-cogging slow rotation down to 3 RPM – direct drive?

Is there anyone (reasonably priced) who might do custom work involving a linear lathe and motor control?

I'm trying to reproduce a simple overhead record mastering lathe and I do have one to help us.

#1 The secret to recording and playback isn't the motor smoothness, but rather its in the flywheel. "Wow and Flutter" is controlled by mass of a flywheel. Even AC motors "start and stop" unacceptably, and digital or stepper motors also do the same. Whichever motor you choose, you will need one that has minimal jerking motion and a flywheel apparatus of some kind attached to smooth out the bumps. The larger the spinning mass and diameter, the smoother the ride. Also a coupler or damper made out of some type of semi hard rubber will take out the torque affect from the input drive and reduce some of the problem.

Rubber belt drives were extensively used in early systems for this purpose, but with today's stepper motors, a simple hard rubber coupler between the motor shaft and the drive gear should do just fine.

Chris
Bieber, CA

#2 A DC drive is capable of producing full torque at zero speed. But you also need one with low-velocity ripple. The motor controller is the easy part since National Semiconductor has the LM12, a power OP-Amp specifically targeting DC motor and servomotor applications providing up to 150 watts of power. Their application note AN-446 discusses the details. The motor, however, needs to also have a tachometer (or similar) for the necessary closed loop control.

Walter J. Heissenberger
Hancock, NH

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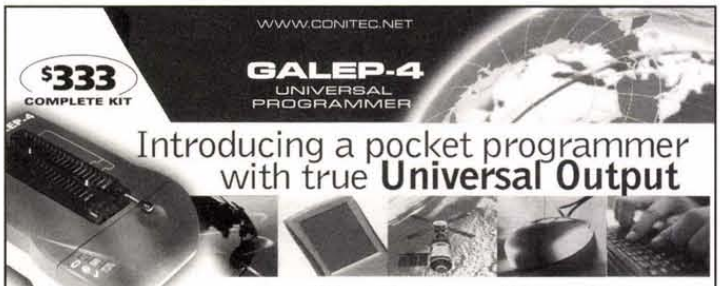

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ware to initialize and optimize the resolution for the display you're using. The company mentioned above is Matco.

Another solution is to purchase an accelerated graphics adapter that has NTSC outputs already on board. Doing this will be more beneficial costwise because you will be upgrading your current Graphics card with a card that is probably more performance enhancing than your current card.

TigerDirect.com sells several converters you connect your computer to that allow you to have your monitor and LCD NTSC display on simultaneously like Matco's product. They also sell Graphics cards with VGA NTSC outputs and some with NTSC inputs. Their address is **TigerDirect.com**, 7795 West Flagler St., #35, Miami, FL 33144. Their phone number is **1-800-888-4437**. You didn't mention what type of input the display has, but most adapters and converters will work with the most common.

Larry Wheeler
Fort Stockton, TX

[4021 - APR. 2002]

I would like to make or buy a serial to USB interface. I thought I remembered a project in Nuts & Volts some time ago in back issues, but don't recall the dates.

I'd have to go through my back issues, but I do recall the device described in the issue was a Future Technology Devices International (FTDI) USB to serial chip.

There is a great deal of information on the FTDI web site at: **www.ftdichip.com/**.

Here you should be able to find product information, schematics, drivers, and everything you would need.

Phillip Stevens
Pocasset, MA

[4026 - APR. 2002]

Would it be worthwhile to try to interface a NEC Silentwriter Model 640 laser printer to a PC?

It has an eight-pin connector (LocalTalk) and the instruction manual describes the function of the pins. I can only locate MAC software for this printer.

I'm afraid that what you want to do is probably not possible, or at least not worth the effort it would take to do it. LocalTalk is the name Apple gave to the physical network hardware which they used to link their computers together, so if this printer has a LocalTalk port on it then it probably expects to be hooked into an AppleTalk network. (AppleTalk is the software protocol which communicates via the LocalTalk hardware; equivalent to the way Novell, Lantastic, or Windows Networking are protocols which communicate via 10BaseT hardware.)

There were some LocalTalk adapters cards made, by both Apple and third-party manufacturers, which would allow you to hook a PC to such a network, but to the best of my knowledge these were all discontinued about 8-10 years ago, and there is very little information available about how they worked. Even if you could locate one, getting it to work under Windows 9x would probably be near-impossible, since to the best of my knowledge no one has ever written anything other than DOS or Windows 3.x drivers for these cards, and I don't think the software which came with them allowed the PC to be anything other than a client to an Apple server, anyway.

Gary Akins
Austin, TX

[4025 - APR. 2002]

I am setting up a diskless workstation. I need a boot PROM for a NIC for a diskless node. Is it possible to "roll my own" boot PROM?

The application is a barebones system that I now bring up from a floppy. The disk has a self-decompressing minimal Linux system on it. I can eliminate the floppy if I boot from the network. But, if I can find a chip to act as a boot PROM with enough memory on it to also store the Linux system, I can eliminate the floppy, and boot without a server.

I believe the exact information you are looking for can be found in the Linux How-Tos, in particular, the Diskless-HOWTO (**www.linuxdoc.org/HOWTO/Diskless-HOWTO.html**).

Information included: Software configuration, boot ROM selection, boot ROM programming, useful links.

One of the links is to **disklessworkstations.com**, which sells ready to go boot ROMs for various NIC flavors for $15.00. That seems pretty cheap to me!

Jim Gallagher
Cypress, CA

[4024 - APR. 2002]

My wife owns a 1998 Honda CRV and lost one of the transmitters to lock and unlock the doors.

The dealer wants about $100.00 to replace it. Is there a cheaper replacement or can I make one myself?

The remote for the CRV Honda needs to be programmed with a code specific to the vehicle to be used on. Otherwise, anyone with a transmitter running on your frequency could unlock your car. Unless you have the time and money to reverse-engineer it, the factory replacement is the better way to go.

Dan Hockey
Des Moines, IA

[4023 - APR. 2002]

In the earlier versions of DOS 6.x, the included Defrag program would allow the user to alphabetize the folders and files to easily find what you were looking for. From Windows 95 on, I haven't found the equivalent way of doing this in a native DOS environment, and a DIR command just brings up a jumble of files and folders that's tough to sort through.

[4028 - APR. 2002]

I have a semi-remote 20 acre property that has a cabin and several buildings on it, but no electricity or phone line. The closest phone terminal is about one-two miles away.

My plans are to attain dialtone and, through an alarm hooked to an autodialer, keep the premises secure.

Is there a way to use RF (i.e., mobile radio, ham, GMRS, FRS) to interface to a telephone to get dialtone? I know there are repeaters, but they are outside my budget.

I have solar panels, batteries, inverters, etc. I am also into electronics.

#1 If you can get analog cellular signals at your lake home, the Motorola three-watt bag phone with the Portable Cellular Connection kit (PN S1936A) will give you dial tone. You can connect any modular phone to the RJ11 jack on the connection kit. You then pick up the phone and dial like normal. The interface and bag phone take care of the dialing and voice on the cellular end.

Alternately, I have converted some digital phones to work with autodialer equipment. I have some products that are able to use the Kyocera digital phone to dial out on alarm.

Luke
via Internet

#2 First of all you should check your location with a cell phone (volunteer a friend if you don't have one). If it is possible to make and receive cell phone calls, your options may improve. Most security systems nowdays have the option of using the local cell phone network to send alarm information back to a monitoring station, which means you will be paying some sort monthly monitoring fee.

Dan Hockey
Des Moines, IA

#3 The phone autodialer is the expensive part because of the legal registration. As a licensed HAM, you could modify a 900 MHz cordless system for this. Some have been known to do similar with FRS, though I question the legal side of that. I have been thinking of a simple repeater controller, with a phone patch option, as a BASIC Stamp article.

Tone ID and Touch Tone control should be fine. Voice ID gets expensive.

(ID is required!) There IS a "hidden transmitter controller" available for around $30.00 that could be adapted in some ways. Try a search for that?

If you can put all of the dialing and phone equipment in a box near enough to the phone pole for a single wire run, then the install cost should not be too high. Then all that you need is the radio links between there and the cabin(s). Just do not forget that all the vandal needs to do is cut the phone line to block the out going call.

Jerel Arbaugh
Pearblossom, CA

How can I to do this without getting a third-party file manager?

Also, when I minimize my Windows program, click on the DOS prompt to go to a DOS window... On my Win 95 machine, the Windows program stays minimized, the DOS C: prompt pops up, I do what I need to do in DOS, close the DOS program and type Exit, and I'm back to minimized Windows program again. If I try this on my Win 98 computer, the computer shuts down and reboots in DOS when I click on the DOS window, thereby dumping my minimized Windows program.

Is this a default settings problem on my Win 98 machine, or is there something fundamentally different between Win 95 and Win 98 in the way each handles DOS window requests?

For a neat directory listing use this command: "set dircmd=/ogn/p" (entered w/o quotes at the DOS prompt or added to your autoexec.bat file). The dir command will now list everything alphabetically starting with the directories and pause at each screen full of data. I don't use XP or ME, but can confirm that this works across all the other flavors of Windows. Type dir/? at DOS prompt for these and other switches you can use.

As to the second part of your question, you'll want to check and compare the properties of your DOS command (which could be a shortcut to, or actually your command.com or DOS-based program). In Windows, right click on the appropriate icon or file and select Properties. Go to the Program tab (second from left) and click on Advanced (near bottom of this screen). On the Win 98 PC, you'll probably notice that the MS-DOS Mode box is checked (whereas it isn't on the Win 95 machine). Unchecking this box on your '98 PC will cause Windows to remain running while you work in DOS, rather that Restarting in DOS mode. You can also change other DOS attributes here, such as whether DOS opens up full screened or windowed, etc. Note that this is only applicable to the DOS command prompt (command.com) or DOS-based programs only.

Ian Carmichael
Queens Village, NY

[3022 - MAR. 2002]

I recently installed an independent PA system in the gymnasium of my local school. I would like to tie this system into the school-wide PA system so that when there is a school-wide announcement, it could use the speaker system that is in place in the gym.

#1 My simple answer is to use a VOX switch circuit like the one in The Encyclopedia of Electronics, Vol 5. from Rudolf F. Graf and William Sheets, at the bottom of page 553. These circuits are pretty simple, this one has only a handful of parts. Put simply, VOX is typically used for automatically starting a tape recorder when an audio signal is heard on the input. When you find one of these circuits (or kit, or possibly even prebuilt), connect the audio/mic input to the schoolwide PA system. Put a single pole, double throw relay on the VOX circuit where it would usually connect to the record button of the tape recorder (in fact, there's probably already a relay in most circuits you'd find). Then connect the Normally Open terminal of the relay to the audio input from the school-wide intercom. Then connect the Normally Closed terminal to the audio source used within the Gym. The Common terminal goes directly to the input of the Gym PA. That's it!

Eric Hungerford
Seattle, WA

#2 First, I am assuming that there is a pair of wires from the office to the gym. On the office intercom, make a small box to mount very close by, preferably metal. It will have a toggle N.O. switch and a 70-volt to 8-ohm transformer in it. The intercom output on the back of the intercom system is most likely a standard 70-volt output. Simply tie across the output with the new transformer with the switch in series with the 70-volt side. Hook the 8-ohm side to the wires going to the gym. At the gym, use an 8-ohm transformer with the secondary being whatever your amp there requires as an input. Using two transformers is safer and provides some isolation.

If no wiring exists between the office and gym, consider using a wireless intercom. Plug one up in the office and one in the gym and try them. If they work, you can open them up and get started. If not, go back to wiring.

If you get good comm with the wireless intercoms: take the office unit and wire up the 70-volt to 8-ohm transformer to the internal speaker with the same speaker switch in series. Most of these intercoms have a lock button, which will allow them to be always "on." At the gym, use a transformer across the speaker to match impedance with you amp.

You're in business! Did the latter at my kids school. Works great!

Ken Williams
via Internet

#3 What you need to install is either an automatic speaker switch or an automatic audio/video switch. This switch monitors both audio and video as a switching criteria. Both devices are made by R.F. Engineering and sold through MCM Electronics, Centerville, OH. Since you may be coming off of a 25 or 70 volt PA System you will probably want to switch the signal source rather than the speakers and therefore have to get the voltage down to the required level through a voltage divider.

Walter J. Heissenberger
Hancock, NH

#4 Most school intercom systems use a constant voltage 25-volt intercom system. Basically, what this means is that at its rated power output, if you put a voltmeter across the output of a 25-volt constant voltage system, you would measure 25 volts RMS. Constant voltage systems are used to overcome resistive losses in audio cable. So basically, you need to grab an unused output off of the switch bank back in the main office (unless you are fortunate enough to already have a run from the switch bank to the gym) and run a shielded cable to the paging amplifier in the gym. Ground the shield on the office side.

At the paging amplifier in the gym, install a 25-volt audio transformer that you ripped off that paging speaker everyone hates in the hallway next to the gym (or you could be honest and buy one at RadioShack). Hook the two conductors from the cable from the office to the half watt tap and common on the primary side of that 25-volt xformer. Do not ground the cable from the office on the gym side. On the secondary of the 25-volt audio transformer (which should be the eight-ohm output), run one lead of that transform through a 33k ohm resistor into an unused aux input of your gym amplifier. Ground the other end of the eight-ohm secondary of the transformer to the ground input of the aux input of the gym amplifier.

Here is why this should work: Most auxiliary inputs of amplifiers have an input impedance of 10k ohms and a sensitivity (voltage required for rated output) of about 150mv. On a 25-volt paging system, you could probably expect a signal of eight-volts RMS on the primary of the 25-volt xformer (rarely are amplifiers operated at their rated output). With a 25-volt half-watt audio xformer, the turns ratio on such a transformer would be 12.5-to-1, so the voltage on the eight-ohm tap of such a transformer would be about 640mv (millivolts) under normal operating conditions. So, the voltage needs to be further reduced into the amplifier to prevent clipping. This is done by the simple voltage divider network created by the 33k ohm resistor in series with the 10k impedance of the aux input of the gym amplifier.

By the way, the 25-volt transformer also provides common mode rejection, which basically means that it will eliminate any hum which might have been induced in the cable running from the office to the gym. Be sure to install the transformer as close to the gym amplifier (within a foot) as possible. Also make sure the cable between the xformer and the aux input is shielded and grounded at the amp.

One final thing, on a 70-volt system, simply substitute a 70-volt audio transformer for the 25-volt and all will be well.

Dan Lash
Expanets of Indiana

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```
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```
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